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DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE
PROPOSED EXPANSION OF WESTERN ENERGY COMPANY'S
ROSEBUD MINE
INTO
AREA B

MONTANA DEPARTMENT OF STATE LANDS
HELENA, MONTANA
April 9, 1976

Submitted pursuant to
Montana Environmental Policy Act
Section 69-6504(b)(3)

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I. INTRODUCTION

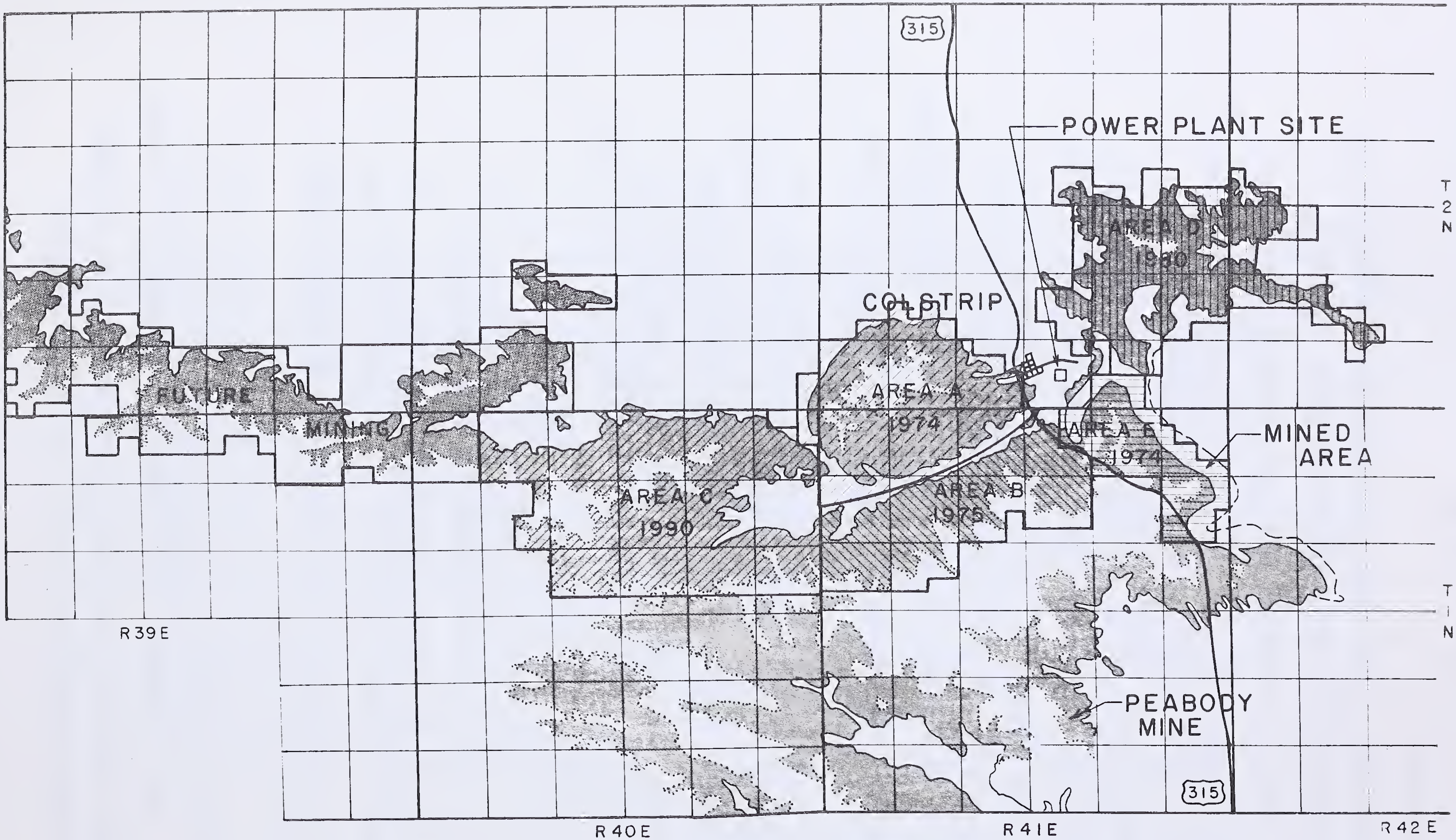
The Department of State Lands (DSL) administers the Montana Strip and Underground Mine Reclamation Act (Title 50, Chapter 10, R.C.M. 1947). The Reclamation Act specifies that, "An operator may not engage in strip or underground mining (for coal or uranium) without first having obtained from the Department a permit . . . ." (Section 50-1039). Strip mine permits are issued for one year at a time and may be renewed annually upon application to the Department. Permit amendments may also be issued, however, when permit acreages are increased the period for which the initial permit was issued is not extended. Also, permit amendments have the same operator application and Department review requirements as do original permits.

On September 30, 1975, Western Energy Company (WECo) submitted an application to amend the 1975 Surface Mining Permit for their Rosebud coal mine. WECo is seeking to expand their mine into a new mining location entitled Area B (Figure I). Specifically, WECo wants to permit 1,176 acres:

(1) 491.22 acres for strip mining or spoiling,
(2) 107.04 acres for haul roads and facilities, and
(3) 577.02 acres for associated disturbance.

Included in the permit application is a request for a dragline corridor to move one of WECo's draglines across Armells Creek into mining area B (Figure II).

The Montana Environmental Policy Act (MEPA) requires that Environmental Impact Statements (EIS) be prepared on "proposals for projects, programs, legislation, and other major actions of state government significantly affecting the quality of the human environment."



COLSTRIP COAL DEPOSIT—ROSEBUD SEAM
(MATSON & BLUMER 1973)

Source: Montana Department of Natural Resources and Conservation, 1974, Draft EIS on Colstrip Electric Generating Units 3 and 4, 500 kilovolt Transmission Lines and Associated Facilities, Helena, Montana, Volume 3A, p. 258.

~ - Limit of Rosebud
⋯ - 150 Ft. Overburden Limit

Figure I

(Section 69-6504, R.C.M. 1947) Pursuant to MEPA, the Department determined that permitting the expansion of WECo.'s Rosebud Mine into a new mining area is major and significant and hence requires that a draft EIS be prepared on the proposed action.

II. LOCATION

WECo.'s Rosebud Mine is located in Rosebud County, Montana, and adjacent to the community of Colstrip. For management purposes, the Rosebud Mine has been divided into areas A,B,C,D,E, and Pit 6 (Figure I). In addition, a large area is designated for "future mining". Area B is approximately one mile south of the town of Colstrip and south of the county road linking Colstrip to Hysham. Principal access to the community of Colstrip is via state highway no. 315 (Figure I).

III. HISTORY OF THE ROSEBUD MINE

The Rosebud Mine was operated from 1924-1958 by the Northern Pacific Railroad as a source of fuel for its steam locomotives. In thirty-four years of mining at Colstrip, Northern Pacific produced forty-four million tons of coal[2]. Spoils from the Burlington Northern operation were left unreclaimed until 1971 when the railroad began a voluntary reclamation program. Most of these old spoils are now at some stage of reclamation.

The Montana Power Company purchased the Rosebud Mine in 1959. In testimony before the Board of Natural Resources in January 1976

Warren P. Schmechel, President of WECo. stated:[2]

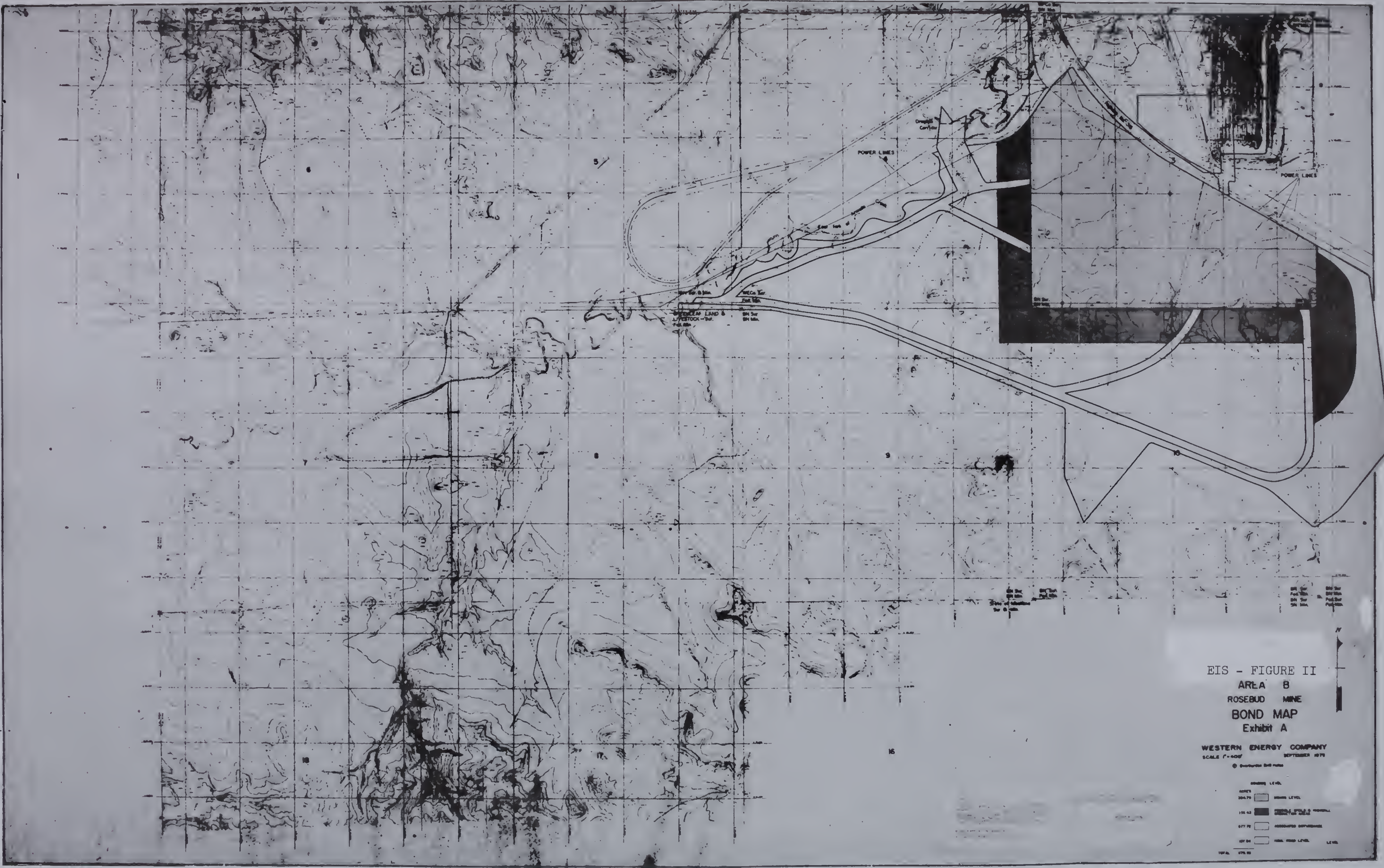
> "Montana Power acquired from Northern Pacific mining leases covering approximately 5 million tons of proven coal reserves, certain large mining machinery, the townsite and accompanying town properties at Colstrip. In 1966, Western Energy Company was formed as a subsidiary of Montana Power to manage the Colstrip properties and development. Additional mining leases, machinery and land have been subsequently acquired by Western Energy Company.
>
> In 1968, Western Energy re-opened the Rosebud Mine at Colstrip. Coal was produced initially for the Montana Power Company's Corette Steam Electric Generating Plant at Billings, commencing in July, 1968. Thereafter, Western Energy Company entered into contracts for the sale of coal to other utility and industrial customers in the Midwest. Coal production since 1968 has been as follows:
>
> 1968 - 150,000 tons
> 1969 - 521,000 tons
> 1970 -1,658,000 tons
> 1971 -5,161,000 tons
> 1972 -5,501,000 tons
> 1973 -4,254,000 tons
> 1974 -3,212,000 tons
> 1975 -6,400,000 tons
>
> Projected production for 1976 is 10,300,000 tons; 1977, 13,000,000 tons; 1978, 13,200,000 tons; 1979, 14,600,000 tons. Assuming that Colstrip (electric generation) units 3 and 4 will be constructed and will be in operation, coal production is projected to reach 19,000,000 tons by 1981."

Currently WECo. is mining in Areas A and E. Pit 6 has been mined and is being reclaimed. WECo. has received eight permit or permit amendments since the company came under the jurisdiction of the Montana Strip and Underground Mine Reclamation Act in 1973 (Table 1). The company's most recent permit was an amendment to expand mining in Area A that was issued by DSL on February 19, 1976. For the entire Rosebud mine, WECo. currently has under permit 1,199 acres for strip mining or spoiling, 107.04 for haul roads and facilities, and 577.02 acres for associated disturbance[3]. These figures indicate that the subject application, if approved, will expand by approximately sixty-two percent WECo.'s acreage permitted under the 1973 Reclamation Act.

IV. MINING PLAN

WECo.'s proposed mining plan for Area B is shown in Figure II. Topsoil will be stripped with scrapers and stockpiled except in the event of wet conditions, when the use of crawler tractors may be necessary. Once topsoil is stripped, overburden will be blasted and then removed with a walking dragline. The dragline to be used in Area B has a 325 foot boom and a 60 cubic yard bucket. After exposure of coal, it will be loaded onto 120 ton coal haulers and taken to the coal processing and loadout facilities presently used for the Area A operation. Haul roads proposed under this application will be connected to the existing Area A haul road network.

The dragline will be used to develop a box cut paralleling the buffer zone along state highway no. 315 with further cuts developing parallel to the box cut in a south-westerly direction. Front end loaders, dozers, and scrapers will periodically be used to compliment



EIS - FIGURE II

AREA B

ROSEBUD MINE

BOND MAP

Exhibit A

WESTERN ENERGY COMPANY

Table 1 - Surface mining permits issued to Western Energy Company(a)

Date Issued	Permit No.	Area
Dec. 17, 1973	73003	Pit 6, Area E, Area A Facilities(b)
July 5, 1974	73003-A001	Addition to Pit 6, Area E Access Road
Sept. 20, 1974	73003-A002	Colstrip Units 3 and 4 Power Plants
Dec. 31, 1974	74003	Dragline Corridor From Construction Pad to Area A
Feb. 24, 1975	74003-A001	Additions to Pit 6 and Area E
April 1, 1975	74003-A002	Area A(c)
August 8, 1975	74003-A003	Additions to Area E and Haul Road to Power Plant
Feb. 19, 1976	76003	Addition to Area A

(a) In compliance with Title 50, Chapter 10, R.C.M. 1947.

(b),(c) Reviewed in a DSL Environmental Impact Statement.

stripping and coal loading facilities.

WECo will be removing only the Rosebud coal seam in Area B. As mining progresses, areas from which the coal has been removed will be refilled, graded, recovered with topsoil and reseeded. The reclaimed surface contours for Area B are shown in Figure XV.

V. DESCRIPTION OF THE EXISTING ENVIRONMENT

A. Physical Environment

1. Topography

The topography of the Colstrip vicinity is typical of much of South Central Montana: sandstone outcrops, ponderosa pine covered hills, and expanses of short grass prairie broken by intermittent creeks and dry washes.[4] The East Fork of Armells Creek is located immediately to the northwest of Area B. The elevation at the south end of Area B varies between 3,330 to 3,370 feet. There are knolls in the south and west rising to 3,400 feet. Level portions of Area B have been planted to grain crops in recent years.

2. Climate

(a) Weather Station Summary

Climatic data for Colstrip is available from the U.S. Department of Commerce and is summarized in the following discussion and in Tables 2 and 3:[5]

> Colstrip has an annual precipitation of 15.79 inches, three-fourths of which falls during the period of April to September. Winter precipitation, mostly falling as snow is light with just over a half inch per month falling during the period of November through February. Summer precipitation almost always occurs as showers. Late spring sometimes will produce rains of several hours in duration, and late September and October in some years can have rainstorms of the same general character. Thunderstorms are common during the summer months - probably occurring about 20 to 30 days a year.
>
> Summers at Colstrip are characterized by warm days, but most nights even during mid-summer, cool down to 60 degrees or less, so really oppressive hot spells are not very common. Temperatures of 90 degrees or more occur about 40 days each year and can occur in any month from May through October; although most of the 90 degree temperatures occur in July and August.
>
> Winters at Colstrip are cold, but not extremely so (Table 3). While minimum temperatures rarely fail

Table 2: Climatic Summary for Colstrip, Montana

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE
IN COOPERATION WITH COOPERATIVE EXTENSION SERVICE

CLIMATOGRAPHY OF THE UNITED STATES NO. 20 - 24

LATITUDE 45° 53'N
LONGITUDE 106° 36'W
ELEV. (GROUND) 3,221 ft.

CLIMATOLOGICAL SUMMARY

STATION COLSTRIP, MONTANA

MEANS AND EXTREMES FOR PERIOD 1941-1970

Month	Temperature (°F)							** Mean degree days	Precipitation Totals (Inches)								Mean number of days					Month
	Means			Extremes								Snow, Ice Pellets						Temperatures				
																		Max.		Min.		
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 inch or more	90° and above	32° and below	32° and below	0° and below	
(a)	30	30	30	30		30		20	30	30		30	30		18							
JAN.	34.2	7.7	21.0	67	1953	-40	1954	1356	.56	.62	1943	5.8	11.7	1963	5.5	1946	2	0	11	30	10	JAN.
FEB.	39.8	13.9	26.9	70	1958	-31	1965	1053	.56	.55	1965	5.8	13.3	1955	6.0	1959	2	0	7	27	6	FEB.
MAR.	45.8	18.9	32.3	80	1943	-28	1945	1001	.74	.95	1943	6.0	15.5	1942	5.0	1954	2	0	5	28	3	MAR.
APR.	59.3	30.1	44.7	87	1962+	3	1947+	624	1.86	2.82	1969	5.1	19.0	1955	8.0	1963	5	0	*	19	0	APR.
MAY	69.2	39.4	54.3	96	1948	13	1954	319	2.47	2.15	1946	*	3.0	1953	2.0	1954	6	1	0	5	0	MAY
JUNE	77.6	47.7	62.7	102	1961	28	1964	105	3.31	3.77	1944	*	8.0	1951	8.0	1951	7	3	0	*	0	JUNE
JULY	89.2	53.8	71.5	107	1960	34	1961	12	1.18	1.33	1962+	0	0	----	0	----	3	17	0	0	0	JULY
AUG.	88.1	52.1	70.1	111	1961	33	1966	24	1.39	1.83	1964	0	0	----	0	----	3	15	0	0	0	AUG.
SEP.	75.9	42.0	59.0	102	1960+	18	1942	203	1.38	1.88	1945	*	7.0	1950	7.0	1950	3	4	0	4	0	SEP.
OCT.	64.8	32.4	48.6	94	1963	7	1941	500	1.04	2.07	1958	2.0	13.1	1946	8.0	1946	3	*	*	15	0	OCT.
NOV.	47.5	21.1	34.3	79	1965	-32	1959	915	.67	1.18	1957	3.1	14.0	1941	8.0	1957	3	0	3	26	2	NOV.
DEC.	38.2	12.8	25.5	71	1957	-35	1964	1202	.63	.58	1958	6.8	15.6	1964	9.5	1958	2	0	9	30	6	DEC.
Year	60.8	31.0	45.9	111	AUG. 1961	-40	JAN. 1954	7314	15.79	3.77	JUNE 1944	34.6	19.0	APR. 1955	9.5	DEC. 1958	41	40	35	184	27	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

+ Also on earlier dates, months, or years.

* Less than one half.

Greatest daily snow for period 1946-1963

Table 3: Temperature and precipitation data for Colstrip, Montana, 1941-1970

COLSTRIP, MONTANA

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1941	26.6	28.8	33.9	43.8	57.0	64.3	73.4	70.8	54.8	44.6	36.8	27.0	46.8
1942	24.2	22.4	34.3	47.8	49.5	59.6	70.1	69.4	58.2	49.4	35.4	24.3	45.4
1943	10.4	29.7	26.3	50.2	52.0	61.2	71.1	70.3	59.0	51.6	36.7	30.8	45.8
1944	27.6	19.5	26.0	45.4	57.4	58.4	68.2	66.5	58.2	51.8	32.2	24.4	44.6
1945	24.6	26.2	36.4	40.8	51.0	57.2	71.6	70.6	57.0	47.8	34.1	21.3	44.9
1946	29.0	30.4	42.4	51.1	50.8	62.2	73.1	68.1	58.0	41.8	31.4	27.0	47.1
1947	27.0	23.4	29.6	42.6	53.7	59.2	74.4	72.8	59.4	51.6	29.6	28.0	45.9
1948	28.2	23.1	29.2	48.3	56.8	63.4	70.5	71.4	62.9	49.2	34.6	19.4	46.4
1949	7.3	15.6	29.7	50.9	57.6	63.2	69.5	71.6	56.4	44.2	44.2	19.1	44.1
1950	2.0	29.4	27.6	41.7	49.6	60.4	66.6	67.7	57.2	51.1	31.2	29.9	42.9
1951	19.7	26.5	21.3	39.8	53.9	56.7	69.7	67.7	54.0	43.9	32.6	14.2	41.7
1952	17.7	28.6	30.2	51.0	55.6	66.6	68.3	69.8	63.5	48.0	31.6	29.3	46.7
1953	32.8	30.9	37.5	39.2	50.1	63.9	73.1	71.1	61.5	53.6	41.1	31.3	48.8
1954	14.9	39.0	27.6	42.9	52.6	60.5	74.6	69.5	60.3	47.9	42.8	32.7	47.1
1955	24.4	21.5	28.1	45.1	54.8	61.4	72.5	72.3	58.5	51.9	21.4	21.2	44.4
1956	20.5	24.2	34.7	41.1	56.0	70.3	70.7	68.0	60.3	49.2	35.5	30.7	46.8
1957	9.5	27.2	34.2	42.6	55.7	62.9	74.6	71.6	59.1	45.4	35.7	37.0	46.3
1958	32.6	25.5	32.4	45.0	61.2	61.0	66.8	72.7	61.6	50.5	35.5	27.7	47.7
1959	21.1	18.0	38.4	43.0	51.3	67.1	71.1	71.5	58.9	44.9	28.1	33.1	45.5
1960	23.7	21.1	32.4	44.9	56.0	64.4	76.3	69.4	61.5	50.3	34.3	28.2	46.9
1961	29.5	36.9	40.6	43.1	56.0	70.8	74.4	75.6	54.3	47.6	32.6	22.0	48.6
1962	21.8	24.9	29.7	50.1	55.2	64.4	68.4	69.2	57.6	52.7	39.6	31.2	47.1
1963	13.1	33.0	40.7	43.7	54.8	64.9	72.4	71.5	66.1	55.0	38.4	22.5	48.0
1964	28.8	29.7	30.0	46.1	56.3	62.6	74.6	65.2	56.0	50.0	28.4	16.8	45.4
1965	25.6	24.8	20.6	45.7	52.9	62.0	70.7	68.2	47.4	51.8	35.7	27.8	44.4
1966	14.3	22.3	36.5	41.4	58.6	62.9	76.3	67.7	65.3	49.5	30.9	25.0	45.9
1967	27.2	31.1	33.1	42.9	52.0	60.9	71.5	71.1	62.8	50.2	34.5	21.0	46.5
1968	20.4	30.3	41.3	43.8	52.0	62.3	70.1	67.1	60.4	49.3	35.1	17.3	45.8
1969	6.3	23.7	30.1	49.5	56.5	60.2	69.0	73.2	62.7	39.8	39.5	27.7	44.9
1970	18.1	31.0	30.1	39.2	56.1	65.6	72.4	72.4	56.0	43.2	33.2	23.7	45.1

COLSTRIP, MONTANA

Total Precipitation (Inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Ann'l
1941	T	.54	.30	2.30	1.14	2.15	2.34	1.35	4.16	1.48	.88	1.09	17.73
1942	.44	.51	1.10	1.97	3.27	4.60	1.54	.51	2.01	1.09	1.10	.15	18.29
1943	1.22	.35	1.68	.94	2.28	3.98	.91	3.04	.48	2.07	.63	.13	17.71
1944	.52	.52	.67	1.58	3.76	10.28	2.13	3.34	.25	.19	.59	.91	24.74
1945	.60	.21	.89	.98	3.34	2.76	.22	.96	2.14	.88	.25	.57	13.80
1946	.62	.25	.50	.87	4.47	2.72	1.08	1.02	3.67	4.19	.44	1.09	20.92
1947	.23	.18	.68	2.59	1.03	3.49	.09	1.02	.92	.28	.43	.35	11.29
1948	.80	.78	.59	2.09	.90	5.78	2.66	.62	.86	T	1.14	.20	16.42
1949	1.19	.84	.88	.50	2.11	1.92	.89	.18	1.03	1.82	.03	.53	11.92
1950	.07	.29	1.59	1.67	2.39	3.15	1.18	.61	2.10	.29	.74	.47	14.55
1951	.36	.38	.32	1.23	1.84	3.71	.74	2.43	1.36	1.12	.36	.93	14.78
1952	.24	.36	.38	.24	3.07	2.34	1.09	1.39	.27	.10	.37	.25	10.10
1953	.50	1.18	.61	1.80	4.21	2.35	1.66	2.08	1.16	3.11	.21	.47	19.34
1954	.56	.29	1.82	1.08	.72	2.21	.44	3.16	.34	.45	.18	.06	11.31
1955	.23	1.31	.46	3.40	5.09	1.81	1.40	.45	.52	1.08	1.03	.73	17.51
1956	.35	.10	.22	1.19	2.99	1.16	1.79	2.86	.58	.49	1.17	.67	13.57
1957	.48	.33	1.07	4.00	2.51	5.01	.16	1.85	1.09	.22	1.68	T	18.40
1958	.24	.49	.38	1.28	1.18	4.08	2.52	.50	.23	3.75	1.04	1.33	17.02
1959	.48	.87	.39	1.68	1.81	1.13	.23	.46	1.59	.82	.89	.10	10.45
1960	.25	.74	1.05	.83	1.72	2.60	.04	1.71	.11	.42	.19	.71	10.37
1961	.21	.79	.19	1.49	2.79	.50	1.18	.87	3.97	1.43	.83	.47	14.72
1962	.61	.45	.66	.64	2.77	3.59	2.87	.59	1.45	.53	.49	.64	15.29
1963	1.16	1.11	.45	3.56	1.99	4.63	1.21	.41	2.19	.02	.36	.75	17.84
1964	.64	.52	.69	2.41	2.29	3.73	1.01	4.16	.19	.51	1.31	1.01	18.47
1965	.89	.80	.56	1.61	1.94	2.98	1.81	1.09	1.82	.00	.42	.42	14.34
1966	.49	.45	.97	1.81	1.39	2.50	1.38	.94	.19	1.38	.60	.89	12.99
1967	.66	.52	1.27	1.95	1.75	3.68	.43	.35	4.12	.61	.62	1.23	17.19
1968	.93	.70	.61	.87	4.06	4.09	.47	3.58	1.73	.58	1.19	1.03	19.84
1969	.92	.13	.37	5.94	1.74	3.82	1.46	.21	.14	1.43	.19	1.25	17.60
1970	.88	.95	.99	3.28	3.46	2.45	.47	.00	.86	.99	.84	.40	15.57

PROBABILITY OF SPECIFIED FREEZING TEMPERATURES (OR COLDER) OCCURRING AFTER GIVEN DATE IN SPRING OR BEFORE GIVEN DATE IN FALL

	SPRING				FALL			
Temp.	75%	50%	25%	10%	10%	25%	50%	75%
32°	May 16	May 24	Jun 1	Jun 8	Sep 1	Sep 9	Sep 18	Sep 27
28°	May 3	May 11	May 19	May 27	Sep 13	Sep 21	Sep 30	Oct 9
24°	Apr 22	Apr 30	May 8	May 15	Sep 23	Oct 1	Oct 10	Oct 19
20°	Apr 12	Apr 20	Apr 28	May 5	Oct 1	Oct 9	Oct 18	Oct 27
16°	Apr 4	Apr 12	Apr 20	Apr 27	Oct 15	Oct 23	Nov 1	Nov 10

In the above table, the 50% point is the same as the average date for each freeze category.

Examples of application of table:

1. One year in four the last 28° freeze will occur by May 19 or later.
2. One year in 10 the first 28° freeze will occur September 13 or earlier.

to cool to 32 degrees or colder during the winter, most days will find afternoons warming to at least the middle thirties. An occasional cold spell will generate sub-zero temperatures, but these spells seldom last more than two or three days. Wind is seldom a factor during cold spells, the coldest portion of a cold wave usually finds the sky clear with a light north to east wind.

Spring and fall are transition seasons between the cold of winter and the warmth of summer, and are the two seasons when day to day changes can be large -- particularly late fall and early spring. The annual average precipitation at Colstrip is adequate for growing many types of grains and grasses. Almost six inches falls during the early part of the growing season when the moisture supply is most important to the vegetation.

(b) Climatic impact upon vegetation

Throughout the arid west, the occurrence of rainfall or lack of it has a tremendous effect on vegetation. The native vegetation, when not under abnormal stress resulting from actions of man, tends to respond to long and short changes in the climate. Drought is no stranger in the Northern Great Plans. All native vegetation found there has earned admission to this harsh ecosystem by surviving drought, fire, intensive grazing by buffalo and other natural pressures. Recent studies correlating weather to vegetation demonstrate a change in community structure as a response to climatic changes.[6] Such vegetational responses persist for several growing seasons.

There are rarely weather monitoring stations at enough locations to give conclusive data concerning the climate-vegetation interaction for any region. However, certain facts about the Northern Great Plains are now understood based on lengthy observation at a few points: rainfall tends to be low as well as very sporatic. Compared to other areas, rains falling during the growing season can be intense but of short duration. Furthermore, the rate of evapotranspiration in this region is usually far greater than the rate of precipitation, making the limited supply of moisture extremely valuable to plants.

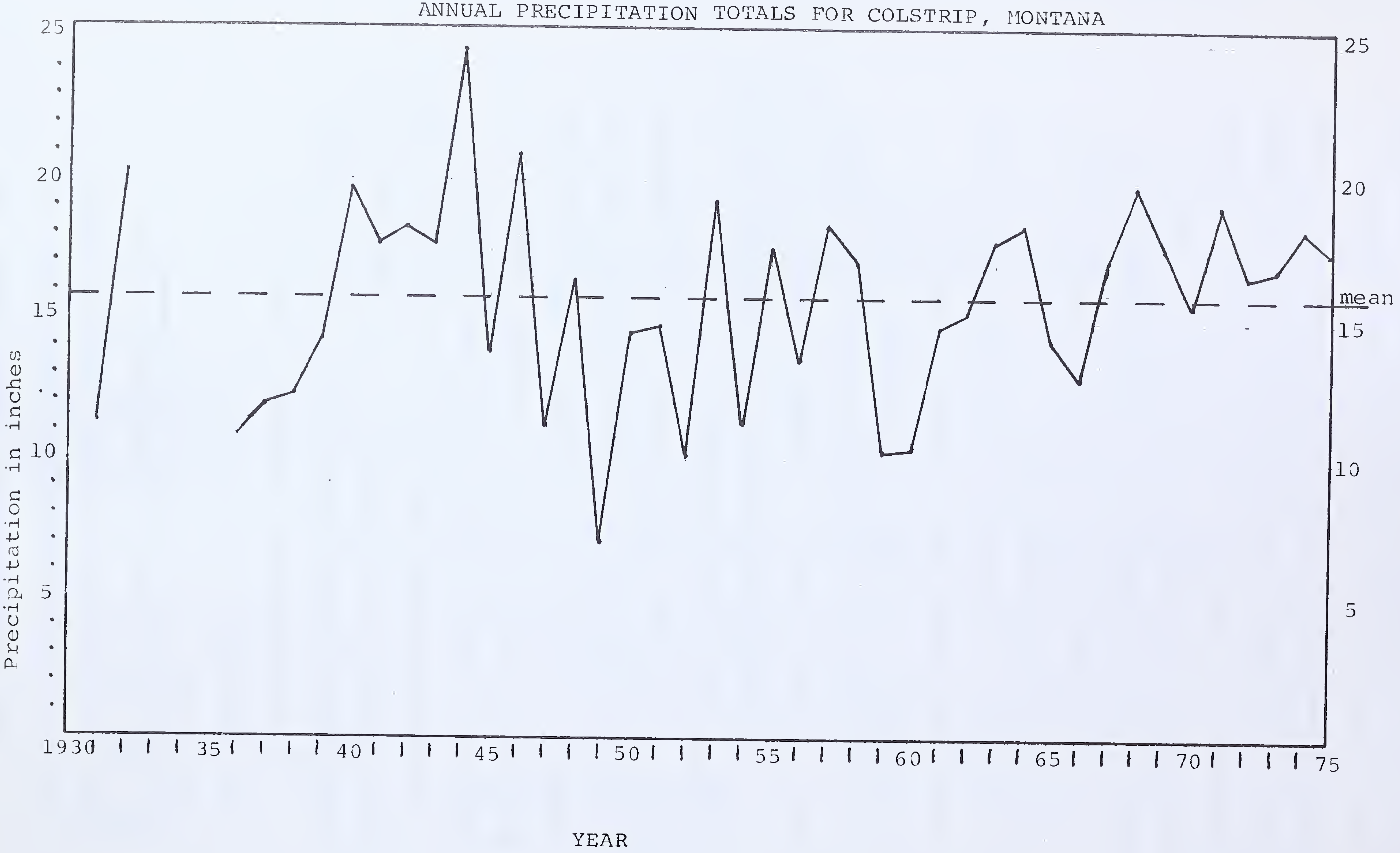
The official mean annual precipitation at Colstrip is 15.79 inches (Table 2). This average, however, is not truly representative as observations for the early droughts of the twentieth century are not averaged into the Colstrip record. These omissions allow the mean to be artificially high.

Droughts in the Northern Great Plains have been observed to occur with a frequency that appears to be in 11 and 23 year cycles.[7] Debate continues as to whether this drought cycle is related to the incidence of sun spots. However, the droughts are fairly regular and can be quite intense.

Precipitation data available for Colstrip has been graphed to show the variation in several totals (Figure III). The variation is quite large, so much so that trends are difficult to clearly distinguish. However, it can be seen that Colstrip has experienced unusually consistent, above average precipitation from 1967 to the present.

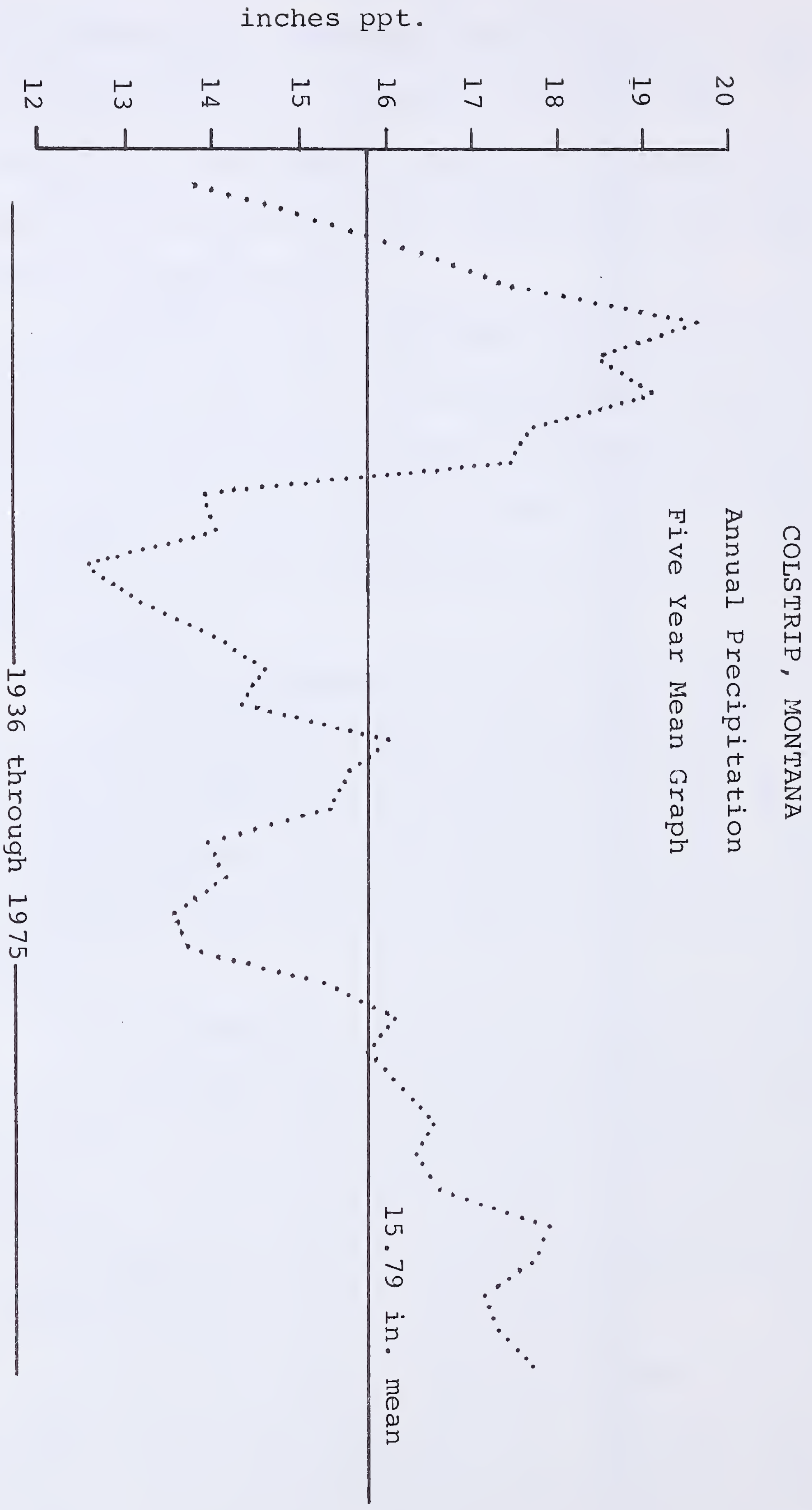
To better illustrate precipitation trends, a five year mean graph was prepared (Figure IV). This latter graph smoothes out precipitation extremes and shows overall trends more clearly. Two prominent precipitation peaks are illustrated, the second of which represents the present point in time.

Figure III



1975: Unofficial Data. Official data previously collected by Western Energy Company has not been submitted to the U. S. Weather Bureau since the Company moved its office.

Figure IV



COLSTRIP, MONTANA
Annual Precipitation
Five Year Mean Graph

Depressed areas shown on Figure IV indicate hard times in the past in terms of moisture available to plants. It is evident that recent reclamation efforts in Eastern Montana have taken place during an unusually optimum moisture phase.

3. Air Quality

(a) Power Plants

The consideration of air quality relative to this proposed operation requires identification of sources of contaminants and areas of air pollution impact. The situation at Colstrip is complicated by the fact that the Montana Power Company is constructing two large coal fired electrical generating plants in the immediate area and is planning to construct two more. The evolution of native vegetation and wildlife in the Colstrip area in recent geological times is not believed to have included the predicted airborne concentrations of toxic power plant emissions as a part of the indigenous environment.

The proposed construction of the two additional electrical generation plants at Colstrip is currently undergoing consideration in hearings being held by the Montana Board of Natural Resources and Conservation. As a result of the Department of Natural Resources' Environmental Impact Statement[8] and the current hearings, much air pollution data has been generated with regards to the operation of these two plants.

Past experience with atmospheric monitoring of areas adjacent to coal fired power plants indicates the emission of numerous toxic, gaseous and particulate substances capable of damaging many forms of biota in areas receiving these pollutants. Primarily, the oxides of sulfur and nitrogen and the emission of fluoride compounds are of concern. Recent estimates indicate the possible emission of 61,000 to 90,000 tons of sulfur dioxide annually into the atmosphere of the Colstrip area.[8] The addition of such substances could pose an abnormal stress upon vegetation, wildlife, cattle and the human occupants of the area.

Of particular interest relative to this impact statement are the possible effects of toxic gases, acid rain and particulates upon both native and replanted vegetation. It is not possible to predict such impacts quantatively at this time, since the occurrence of these problems relates not only to the efficiency of pollution abatement, but also upon the climate in the form of other stress factors as well as confinement and transport of pollutants. Furthermore, few studies concerning air pollution effects have focused on the species of native vegetation and wildlife found in the Colstrip area.

It is possible that future study of the native and reestablished biota in the Colstrip area may necessitate the recognition of abnormal concentrations of toxic substances. Any temporary shift in the native vegetation community composition will serve to create ambiguities in the evaluation of reclamation success. Such shifts in specie composition due to temporary or intermittent air pollution stress could be further augmented by long term accumulation of toxic substances in the upper layer of soils.

The leaching of abnormal substances into the soil such as heavy metals and sulfates has caused changes in pH and the balance of soil microorganisms in other areas subject to power plant emissions.[8] As a result of surface run-off, changes in the chemical character of soil may also be accompanied by a chemical shift in aquatic ecosystems.

The potential for stress caused by power plant emissions in adjacent mining areas must be considered when evaluating the existing biota as well as when evaluating reclamation efforts.

(b) Coal Mine Emissions

Interacting with potential power plant emissions in the Colstrip area are those particulate emissions generated by the surface disturbance associated with mining. Projected future plans for the Rosebud Mine show extensive, long term surface disturbance in areas northeast, northwest, west, southwest, south, and southeast of the town of Colstrip. The removal of the protective vegetative cover followed by blasting, excavation and transport of mining spoils results in the release of particulates to the atmosphere. In addition, the constant movement of large mobile equipment through exposed spoil surfaces and along haul roads also creates surface disturbances that liberate large amounts of fugitive dust. The presence of high atmosphere particulate concentrations has long been recognized as a nuisance for man.

As more effort has been expended in the study of environmental problems resulting from particulate pollution, new laws and health standards have been established to reduce the causes. Both the federal government and the State of Montana have adopted standards governing particulate pollution. Furthermore, the rules and regulations adopted pursuant to the Montana Strip and Underground Mining Act addresses the particulate problem in mining activities with the following regulation:

> "All appropriate methods shall be employed by the operator to prevent loss of haulage or access road surface material in the form of dust" (MAC 26-2.10(10)-S10320(2))

The Reclamation Act itself addressed itself to this problem in a more general sense:

> "An operator may not throw, dump, pile...any overburden... mineral, earth, soil, dirt, debris...outside of the area of land which is under permit...or place the materials described in this section in such a way that normal erosion...brought about by natural physical causes will permit the materials to go beyond or outside of the area of land which is under permit". (Section 50-1043(3) R.C.M. 1947)

The above section of the Reclamation Act being broader in its prevention of dust emissions, goes beyond the singular consideration of haul roads as dust emission points from mining operations.

In an effort to generate an understanding of the impacts of dust emissions from the proposed mine expansion, it is necessary to review past monitoring experience at Colstrip and to discuss the difficulties in establishing the threshold levels of pollution that could be used to enforce the Reclamation Act.

In that the Reclamation Act attempts to regulate and mitigate environmental damages resulting from mining operations, certain standards need to be understood by both DSL and the permittee.

The Reclamation Act, unlike other laws relating to air quality in its lack of explicit standards, must rely upon prudent distinction between naturally occurring levels of contamination or damage and abnormal levels of contamination which are the result of the mining activities. Naturally occurring levels of air borne particulates do fluctuate in concert with other environmental parameters. It is generally understood that during very dry periods, even remote areas will assume higher ambient levels of dust in the atmosphere. Air sampling has been performed in Montana in an effort to understand more fully what these levels are in isolated areas. Table 4 gives high volume air sampling data representative of background levels taken from the files of the Air Quality Bureau of the Montana Department of Health and Environmental Sciences.

Until the onset of mining, and particularly public awareness of power plant construction, little attention was given to the Colstrip area concerning the need for particulate sampling.

The results of MPC's air monitoring are submitted to the Montana Air Quality Bureau. Eleven monitoring sites in the immediate vicinity of Colstrip are illustrated on Figure 5. The most centrally located site is #3, located near the center of town in a residential area.

Figure V

COLSTRIP, MONTANA

ENVIRONMENTAL MONITORING SITES

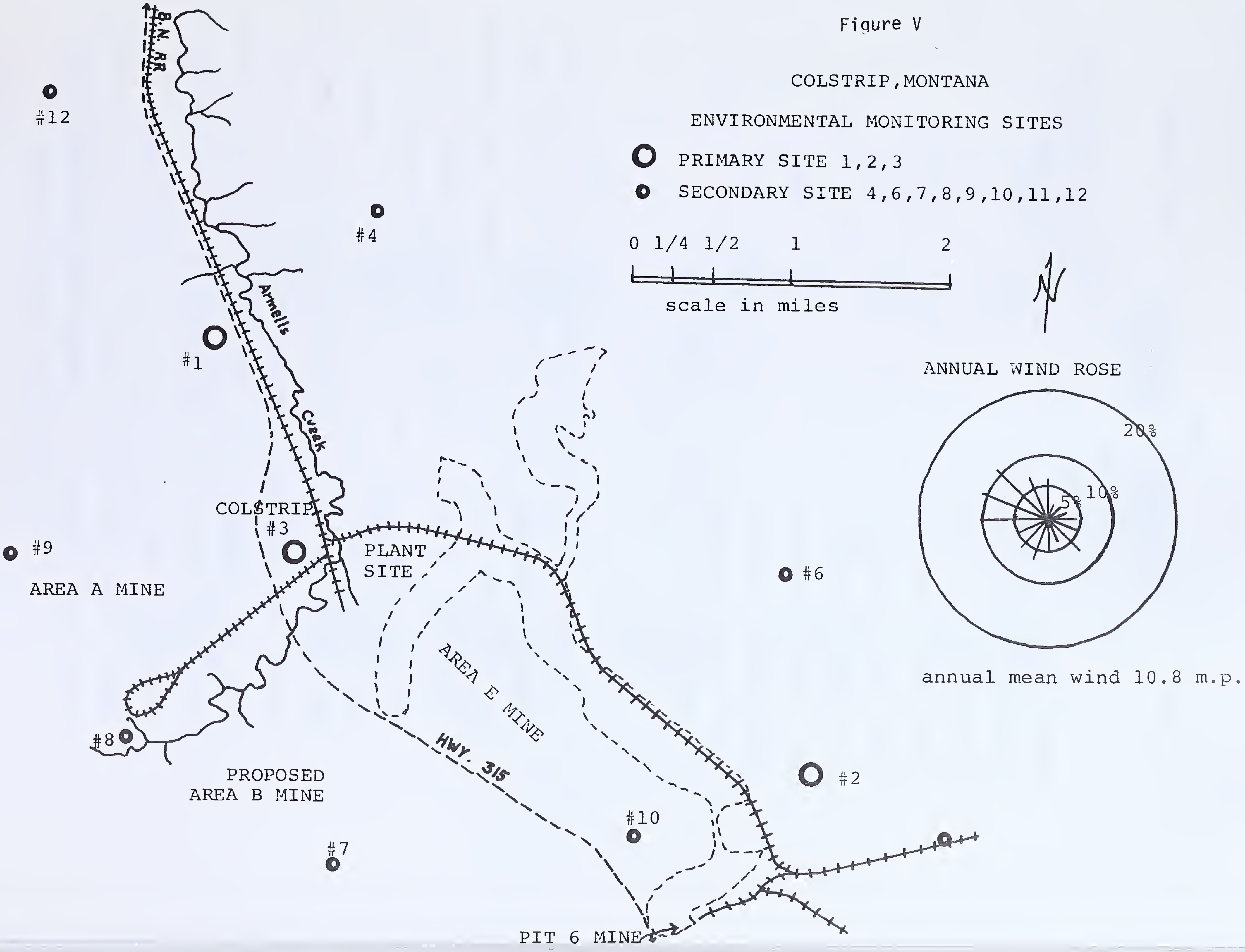


Table 4 - Background Air Particulate Levels for Eastern Montana

Sample Location	Four Month Geometric Means Expressed in Micrograms Per Cubic Meter ($\mu g/m^3$)
4 mi. West of Poplar	12.66
Near Ekalaka	6.99
14 mi. North of Scobey	7.35
15 mi. East of Glendive	18.89
21 mi. North of Lindsay	11.61 - 12.33(b)
4 mi. East of Fort Peck Dam	15.39
6 mi. Southeast of Broadus	10.09

(a) September, October, November and December, 1975

(b) Two high volume samplers operating

A summary for high volume air sampling at Site #3 during 1972 is presented in Table 5. Values for particulate concentrations range from 4.15 to 166.15 $\mu g/m^3$. There are no overwhelming trends apparent in this data. The months of December, January and February are uniformly lower while a period beginning in mid-May and extending to mid-August is uniformly above average. During 1972 Colstrip had many unpaved streets which are recognized as sources of air borne particulates. Mining had been going on since the fall of 1968, but was in an area several miles southeast of town known as Pit 6. The prevailing winds in May through August of 1972 were variable but did show prominent southeasterly vectors particularly in June, July and August. The December, January and February winds during 1972 show little tendency to blow from the southeast. (For wind direction data, see the Wind

Table 5

HIGH VOLUME AIR SAMPLING DATA
Station No. 3 1972
Particulate in Micrograms per Cubic Meter

Colstrip, Montana

January	4.84
	4.15
	37.79
February	5.80
	10.20
	21.93
	22.44
March	29.70
	33.00
	50.90
	166.15
	56.71
	64.64
April	80.85
	41.66
	61.16
	70.28
	49.99
May	36.52
	46.24
	78.61
	65.50
	77.78
June	105.43
	66.62
	77.28
	77.52
	78.64
July	96.70
	87.00
	64.94
	52.84
	80.10
	91.67
August	127.03
	105.22
	86.03
	38.38
	27.55
September	16.59
	32.77
	79.62
	81.30
	32.57
October	35.31
	54.86
	23.80
	114.80
	22.50
November	38.40
	104.20
	87.80
	107.60
	72.40
December	32.90
	20.00
	27.51
	28.91
	31.77
	22.04

GEOMETRIC MEAN = 45.68

Source of raw data: Montana Power Co.

Roses for Colstrip for 1972 given in Appendix A). During 1972 little other disturbance, aside from the Pit 6 operation was occurring in the Colstrip vicinity.

A look at air sampling data for 1975 reveals significant differences in the concentration of air borne particulates (Table 6). For best interpretation of this data, wind measurements are beneficial. Such measurements, similar to the Wind Roses for 1972, are not available. The increase in mining activity at Colstrip, however, may still be shown by comparing changes in air quality data.

By 1975 Pit 6 area had been largely recontoured and operations had moved into Area E, much closer to town (sampling site #3). Furthermore, in April of 1975 operations had begun in Area A, very close to the town area to the west. Particulate sampling data from site #3, indicates an 89% increase above the 1972 data (Tables 6 and 7). In addition, conditions local to site #3 had also changed since 1972 because most of the streets in the area had been paved and because of an increase in precipitation; both factors, which would normally be expected to reduce the local atmospheric particulate concentrations.

Station #3 has been in operation longer than any other air monitoring station and therefore offers a longer term data base for evaluating changes in atmospheric particulate loads. The trend for increased particulates has been shown by comparing 1972 with 1975. A clearer view may be obtained by graphing sample values over time to give a visual description of this increase. Figure 6 illustrates changes which took place between September, 1973 and December, 1975. The values shown in late 1973 and early 1974 were not tabulated in geometric means. However, the data appears to comply with federal standards. In mid-1974 concentrations increase dramatically and again fall during

Table 6

HIGH VOLUME AIR SAMPLING DATA
Station No. 3 1975
Particulate in Micrograms per Cubic Meter

Colstrip, Montana

January	96.64
	30.67
	79.96
	106.04
	32.11
February	37.51
	27.55
	23.09
	89.98
	126.04
March	123.96
	29.49
	281.75 (2)
	36.99
	53.55
April	55.61
	49.27
	146.57
	76.39
May	129.43
June	(no data)
July	144.46
	75.03
	259.83
	173.17
	309.47 (2)
August	84.87
	194.04
	134.22
	85.05
	125.65
	127.11
September	(no data)
October	143.81
	117.95
	176.50
	218.06
November	271.97 (2)
	412.61 (2)
	15.20
	31.46
	14.19
December	56.65
	16.69
	61.00
	83.90
	80.41

GEOMETRIC MEAN = 86.19 (1)
89% increase above 1972

(1) National Ambient Air Quality Standards: Primary Standard Particulate matter - 75 micrograms per cubic meter annual geometric mean. Two hundred and sixty micrograms per cubic metermaximum. Twenty-four hour concentration not to be exceeded more than once a year.

(2) Federal Standards exceeded four times in 1975.

Source of raw data: Montana Power Co.

Table 7

DUSTFALL COLLECTION STATION #3 (1)
(September 30, 1974 through January 31, 1976)

Colstrip, Montana

Collection Periods	Dustfall Tons/sq.mi.	Three Month Mean Tons/sq.mi.	Exceeds(2) Residential Standard	Exceeds Industrial Standard
9-30-74 to 10-30-74	46.10	(4)	-	-
10-30-74 to 11-30-74	59.51	(4)	-	-
11-30-74 to 12-30-74	24.08	43.2	188%	44%
12-31-74 to 1-31-75	26.84	36.81	145%	23%
1-31-75 to 3-1-75	(3)	-	-	-
3-1-75 to 3-31-75	(3)	-	-	-
3-31-75 to 5-1-75	33.15	28.02	87%	0
5-1-75 to 6-1-75	37.11	32.37	116%	8%
6-1-75 to 7-1-75	29.23	33.16	121%	11%
7-1-75 to 7-31-75	40.57	35.64	138%	19%
7-31-75 to 8-30-75	57.33	42.38	183%	41%
8-30-75 to 9-30-75	56.17	51.36	242%	71%
10-1-75 to 11-1-75	45.43	52.98	253%	77%
11-1-75 to 12-1-75	90.57	64.06	327%	114%
12-1-75 to 1-3-76	39.71	58.57	290%	95%
1-3-76 to 1-31-76	62.55	64.28	329%	114%

(1) This station is located behind the previous Western Energy Office in a residential area of Colstrip.

(2) Ambient Air Quality Standards. In accordance with Section 69-3909, subsection 12 of the Clean Air Act of Montana, on May 7, 1967, the Board adopted the Ambient Air Quality Standards shown below:

Settled Particulate (Dustfall)	15 tons per square mile per month 3-month average in residential areas 30 tons per square mile per month, 3-month average in heavy industrial areas.

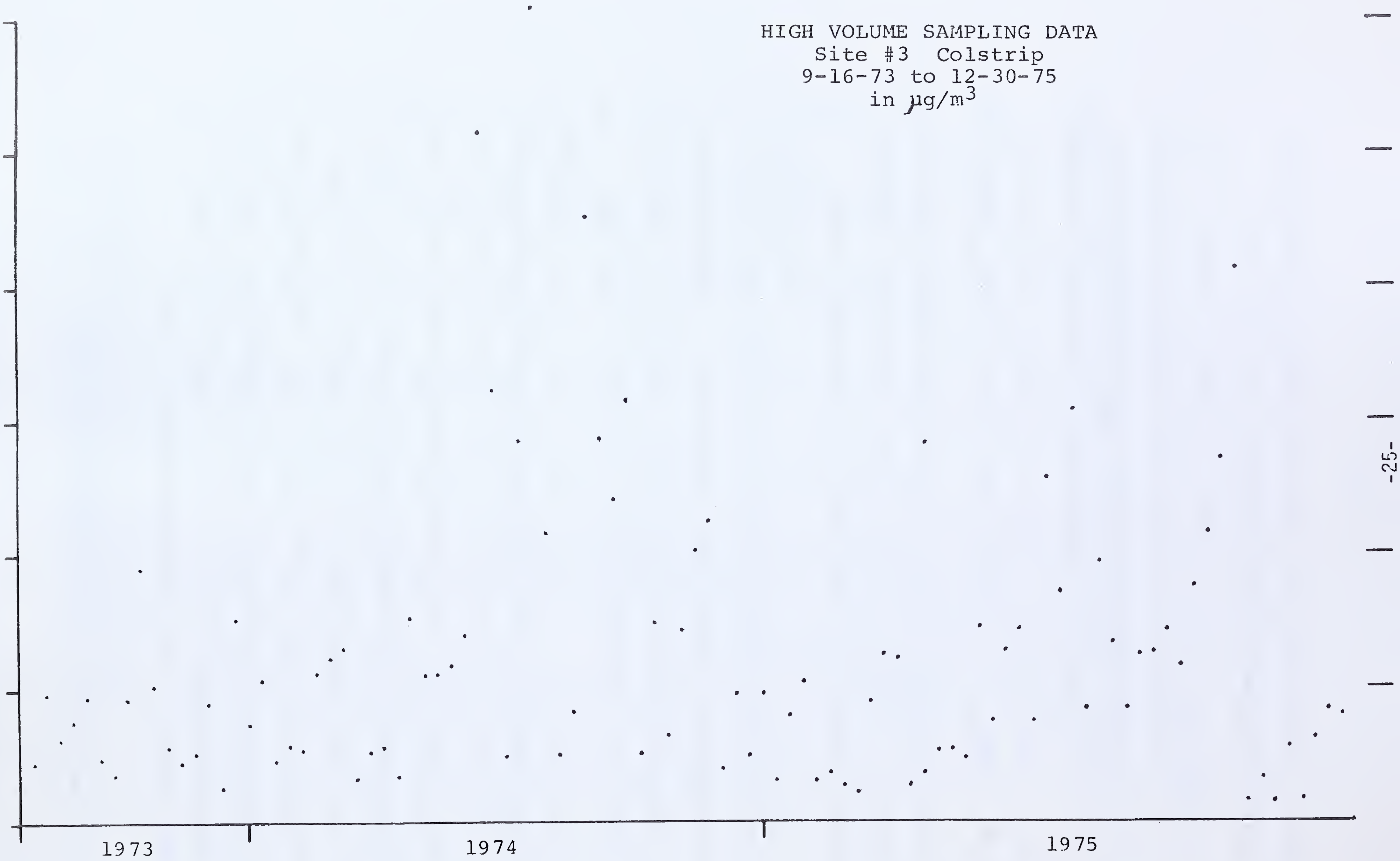
(3) No data for this period.

(4) 3 month mean = add 3 consecutive months and divide by 3.

Source of raw data (tons/sq. mi.): Montana Power Co.

Figure VI

HIGH VOLUME SAMPLING DATA
Site #3 Colstrip
9-16-73 to 12-30-75
in $\mu g/m^3$



winter months. Early 1975 is again low, but concentrations pick up more quickly.

It is difficult to equate these high levels to the occurrence of mining activities without detailed weather data on site. There has been a local weather station in the town of Colstrip since 1929. When Montana Power took over the town, they also took over the weather station and continued to report their observations to the U. S. Weather Bureau. Late in 1974 the company abandoned their weather station and the last recorded official record published by the Weather Bureau is for the month of October, 1974. The recent lack of precipitation and wind monitoring data at Colstrip makes other data interpretation more difficult.

Activities at the town of Colstrip increased in 1974 possibly resulting in a potential for more localized particulate loads in the town atmosphere. To seperate the town activities from background particulate levels resulting from mining in upwind directions requires further inquiry.

Another method utilized by the Montana Power Company to monitor atmospheric particulate levels is dust fall collection. Collection sites were chosen and dust collectors were normally deployed at a site for a period of one month. Results are calculated to represent the rate of dust settling to ground level in units of tons per square mile per month. Collection data for six sites were tabulated (Table 8). From October, 1974 through January, 1975, monitoring was continuous. Site #3 maintained a uniformly high level of particulates for a residential area, and there was a tendency of increasing concentration during this period (Table 8).

As mentioned earlier, changes in weather, particularly rainfall, are believed to influence atmospheric particulate loads. To demonstrate

Table 8

DUSTFALL COLLECTION STATIONS
September 30, 1974 through January 31, 1976
Measured in Tons/Square Mile

Colstrip, Montana

Collection Periods	#2	#3	#6	#7	#8	#9
9-30-74 to 10-30-74	56.41	46.10	24.91	10.48	64.99	21.78
10-30-74 to 11-30-74	(2)	59.51	(2)	7.94	42.95	7.85
11-30-74 to 12-30-74	13.56	24.08	10.56	8.83	28.67	10.65
12-31-74 to 1-31-75	14.76	26.84	7.14	6.71	91.99	3.05
1-31-75 to 3-1-75	(2)	(2)	(2)	(2)	(2)	(2)
3-1-75 to 3-31-76	(2)	(2)	(2)	(2)	(2)	(2)
3-31-75 to 5-1-75	15.93	33.15	14.53	39.57	21.38	(2)
5-1-75 to 6-1-75	13.79	37.11	15.27	30.38	16.38	27.52
6-1-75 to 7-1-75	21.07	29.23	17.96	72.89	35.97	31.44
7-1-75 to 7-31-75	7.79	40.57	11.25	8.72	36.43	15.02
7-31-75 to 8-30-75	13.79	57.33	9.79	13.25	119.28	9.51
8-30-85 to 9-30-75	11.52	56.17	11.92	12.02	23.25	9.77
10-1-75 to 11-1-75	7.19	45.43	6.26	7.23	34.66	4.37
11-1-75 to 12-1-75	7.10	90.57	10.05	228.34	51.62	(2)
12-1-75 to 1-3-76	48.91	39.71	7.66	28.89	34.31	26.34
1-3-76 to 1-31-76	17.62	62.55	29.15	40.77	50.76	24.55
MEAN	19.19	46.31	13.57	36.86	46.62	15.99

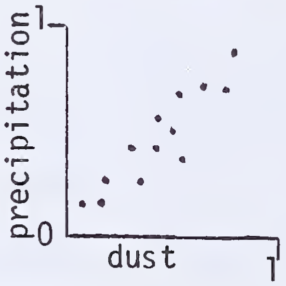
(1) These Dustfall Collection Stations are operated by the Montana Power Company. Monthly reports are usually sent to the Air Quality Bureau, Montana Department of Health and Environmental Science.

(2) Data not available due to mistakes in sampling or lab analysis or being lost.

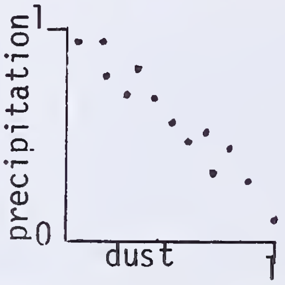
Source of raw data: Montana Power Co.

the relationship between particulates and precipitation, the dust fall sample period shown on Table 7 was used. The six stations were averaged by month of collection period. Weather records were checked in order to tabulate precipitation for each of the sample periods. Due to a lack of Colstrip data, three surrounding stations were used, and their precipitation records were averaged.

The results of this averaging are shown on Table 9. The data in Table 9 is presented graphically in Figure VII. The distribution of points shown here attempts to illustrate a relationship between precipitation and atmospheric particulates. If precipitation had a strong influence in either causing or preventing high particulate concentrations, the grouping of data points would tend to be aligned as follows:



precipitation causes dust



precipitation prevents dust

When the above example is mathematically analyzed, it yields a correlation coefficient near 1.00. The data presented on Figure VII yielded a correlation coefficient of .064 which shows extremely insignificant correlation. This indicates that for this sample period, something besides precipitation was controlling the level of atmospheric particulates in and around Colstrip. Although this does show that the occurrence of particulates is unrelated to precipitation during this period, it does not, however, isolate mining dust from town dust, because station #3 is located in town.

To look more closely at mining dust emissions it is necessary to remove the analysis from town to a sampling station closer to a mining

Table 9

Colstrip, Montana

Mean Values For:

DUSTFALL COLLECTION STATIONS AND PRECIPITATION COLLECTIONS

		Precipitation (inches)				
Collection Periods	Dustfall (1) Mean T/Mi^2	Colstrip	Forsythe	Lame Deer	Brandenburg	Ppt. Mean
9-30-74 to 10-30-74	37.45	3.76	-	-	-	3.76
10-30-74 to 11-30-74	29.56	-	.42	.56	.51	.50
11-30-74 to 12-31-74	16.06	-	.07	.33	.26	.22
12-31-74 to 1-31-75	25.08	-	1.14	(3)	1.72	1.43
1-31-75 to 3-1-75	(3)	-	.10	.53	.41	.35
3-1-75 to 3-31-75	(3)	-	.43	1.06	1.07	.85
3-31-75 to 5-1-75	24.91	-	2.98	3.36	4.50	3.61
5-1-75 to 6-1-75	23.41	-	3.36	3.28	2.87	3.17
6-1-75 to 7-1-75	34.76	-	2.56	2.74	4.05	3.12
7-1-75 to 7-31-75	19.96	-	4.05	1.49	.61	2.05
7-31-75 to 8-30-75	37.16	-	.30	.29	.67	.42
8-30-75 to 9-30-75	20.78	-	(3)	.03	.39	.21
10-1-75 to 11-1-75	17.52	-	2.68	1.17	1.78	1.88
11-1-75 to 12-1-75	77.54	-	1.47	1.92	1.26	1.55
12-1-75 to 1-3-76	30.97	-	1.00	1.12	1.11	1.08
1-3-76 to 1-31-76	37.57	-	(4)	(4)	(4)	(4)

(1) Dustfall Means calculated by using data from stations #2, 3, 6, 7, 8, and 9 in and around Colstrip .

(2) October 74 was the last weather report from Colstrip as published in Weather Bureau records. Though they are of inferior statistical quality for this purpose the other three stations presented are used to triangulate Colstrip and generate a "best monthly mean" in order to correlate moisture with atmospheric particulate load.

(3) No data collected.

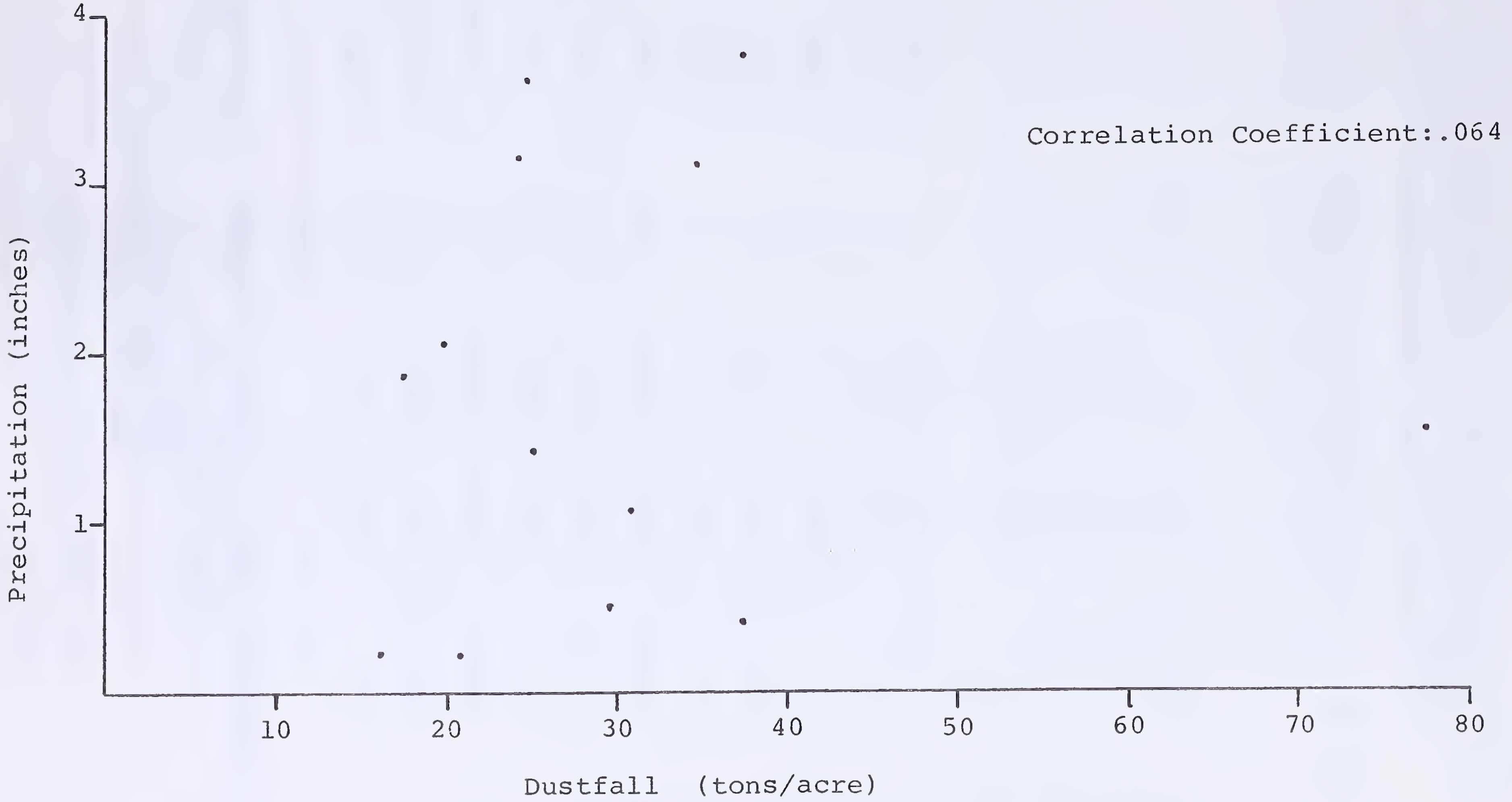
(4) Precipitation data not yet available.

Source of raw data: Montana Power Co. and U.S. Weather Bureau

Figure VII

Colstrip,Montana

Mean Dustfall Collections: Stations 2,3,6,7,8&9
v.s.
Mean Precipitation: Forsythe, Lame Deer,& Brandenburg
(October, 1974 through January, 1976)



operation. Station #8 was selected for analysis for the above reasons. Furthermore, there is a sufficient sample period (September, 1972 - January, 1976) to allow a demonstration of change which is meaningful. Station #8 is near mining Area A, and mining Area A is located in a predominantly upwind direction from Colstrip, and virtually borders the town on the west. The dust fall collection values for station #8 are presented in Figure VIII.

Station #8 is not totally removed from all possible dust sources prior to mining. There is some agricultural activity in the vicinity which may cause particulate levels to exceed normal background levels. However, until mid 1974, the particulate levels remain low with a good degree of consistency.

During 1974 Western Energy constructed the railroad loop and load-out facilities in this area. During April of 1975, mining operations in this area began and are still continuing. The great increase in particulate collections at station #8 beginning in mid 1974 and increasing through 1975 is believed to result from such mining and associated activities.

To again distinguish between natural and mining causes in the production of atmospheric particulate loads, precipitation data was correlated with particulate loads. The same precipitation data was used here as that found on Table #9. For the time period October, 1974 until January, 1976, the correlation coefficient is .234. This coefficient is also of such a low value as to indicate a very low relationship between precipitation and dust fall. This time period covers the most extreme period of dust fall shown on Figure VIII. Furthermore, it is also during this period that station #8 exceeded the values of station #3. Based on these observations, and the data supplied by the company

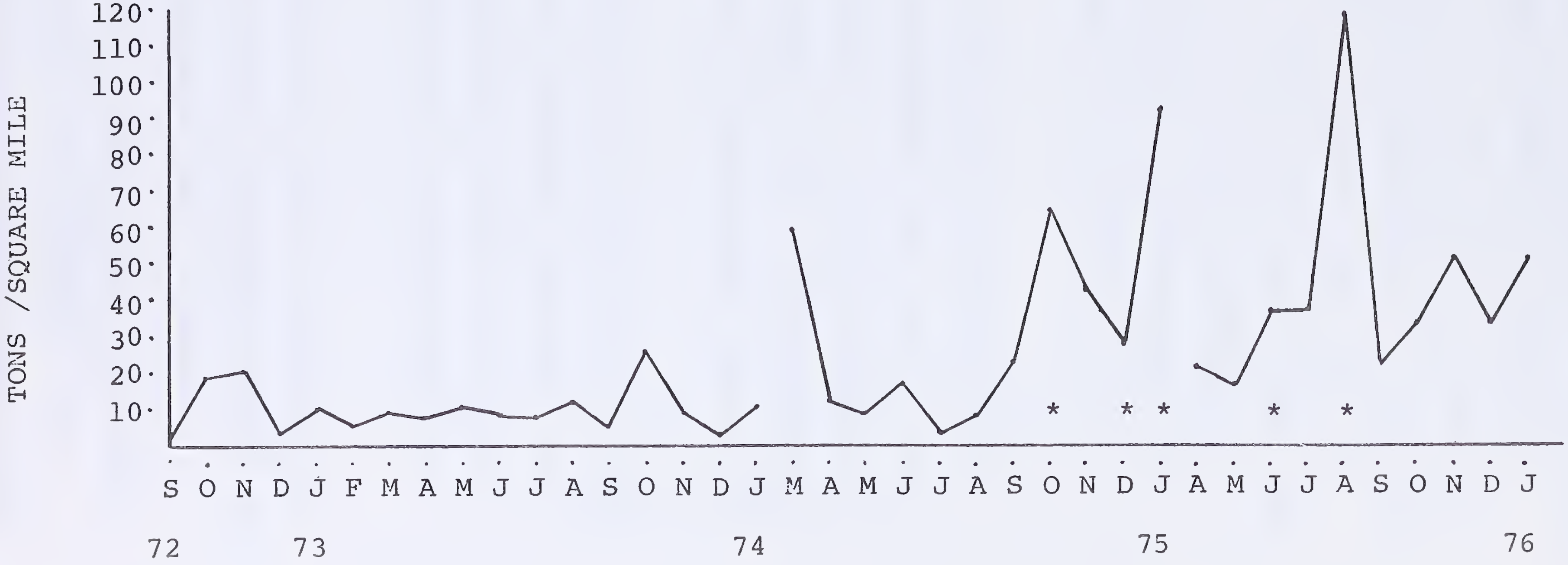
Figure VIII

Colstrip,Montana

DUSTFALL COLLECTION STATION
#8

September 1972 through January 1976

(*) Dustfall Greater Than #3



that is presented here, it becomes clear that mining operations at Colstrip are creating a dust problem far in excess of natural causes.

The above air quality data cannot at this time be considered to demonstrate precise quantitative conclusions. The analysis of the values is of an informal nature and lacks site specific precipitation and wind observations. Furthermore, the methods used in calculation may be further refined by adoption of the Air Pollution Control Association recommendations of July, 1966.[9] The above calculations, graphs and conclusions are presented in an effort to demonstrate trends which are evident and which could generate further inquiry by agencies and personnel who have greater access to site specific weather data and have more sophisticated abilities in data analysis.

The presentation of these trends is believed, however, to assist in explaining the visual observations made by Department of State Lands personnel. Observations have been made at Colstrip which reveal excessive air borne transport of dust in this mining area. The prevailing winds have been observed to carry large amounts of dust from the present Area A operation into the town. Also, the spread of coal dust appears to be increasing in downwind locations adjacent to haul roads, coal handling and loadout facilities. Due to a lack of detailed survey data, the exact size of areas and rate of enlargement is not known.

4. Geology

The youngest sedimentary unit in the Colstrip area in the Tongue River Member of the Fort Union Formation, of Paleocene age. This unit, which comprises interbedded sandstone, siltstone, and shale has a maximum thickness in the Colstrip area of about 450 feet. A generalized stratigraphic column of the Fort Union formation in the Colstrip area is shown in Figure IX.

Two significant coal seams occur within 200 feet of the surface in the Colstrip area. The upper of these, the Rosebud seam, has a thickness of about 17-25 feet and is currently being mined at the Western Energy mine as well as at Peabody's Big Sky mine immediately to the south. In Area B the Rosebud seam averages about 18.4 feet in thickness.

The 8 foot thick McKay coal seam underlies the Rosebud, seperated by innerburden which ranges from 8-25 feet in thickness, averaging 20 feet. McKay coal is not currently being mined at the Western Energy mine, being alledgedly unmarketable because of its higher sulfur content. A comparison of Rosebud and McKay coal is presented in Table 10.

Table 10. Comparison of Rosebud and McKay Coal in the vicinity of Colstrip.(a)

ROSEBUD COAL - AVERAGE EIGHT HOLES

	Max.	Avg.	Min.
Moisture %	26.47	26.01	24.98
Ash %	9.67	8.12	7.19
Volatile %	31.88	30.50	28.80
Fixed C %	37.02	35.37	33.65
BTU	8866	8703	8473
Sulphur %	0.82	0.61	0.42

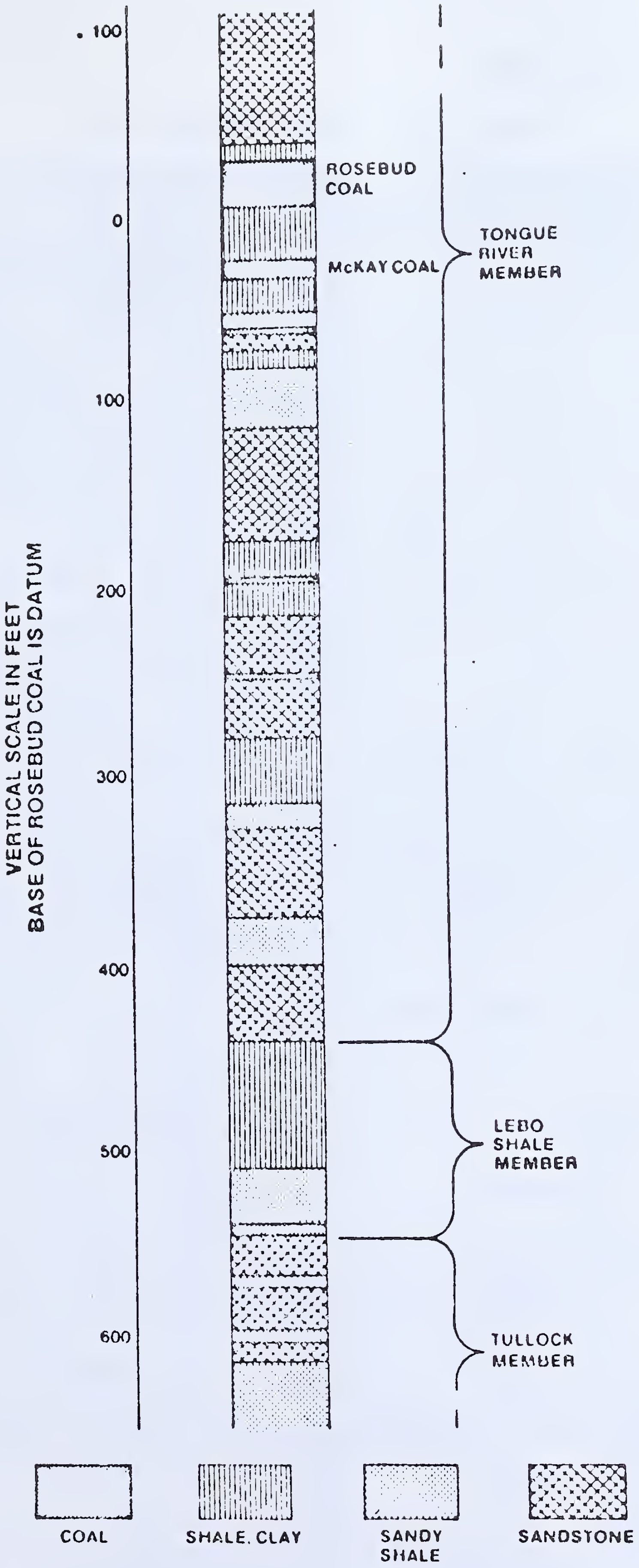


Figure IX STRATIGRAPHIC COLUMN OF THE FORT UNION FORMATION AT COLSTRIP, MONTANA

(Table 10 Continued)

MCKAY COAL - AVERAGE SEVEN HOLES

	Max.	Avg.	Min.
Moisture %	28.36	27.33	25.31
Ash %	7.56	6.40	5.16
Vilatile %	30.29	28.38	27.29
Fixed C %	39.04	37.88	37.14
BTU	8888	8728	8551
Sulphur %	1.71	1.17	0.52

(a) Source: Western Energy Company

Overburden thickness varies greatly in Section 3 - the section designated for mining in this first Area B application. In the northern part of the proposed mining area along the 4800N parallel, Rosebud coal occurs within 20 feet of the surface. Overburden thickness increases progressively southward, being as much as 180 feet along the 4500N parallel, although it is also as little as 50 feet because of considerable land surface relief and anticlinal flexures in the coal seam.

5. Soils

Soils in Area B comprise nine major series, which are further divided into eighteen soil types (Figure X). The series are: Bainville, Midway, Fort Collins, Remitt, Heldt, McRae, Thurlow, Tullock, and the Red Rock Outcrop Complex. The soil types and their approximate respective salvage depths are listed in Table 11. Descriptions of each series and their chemical properties are included in Appendix B.

EIS - FIGURE X

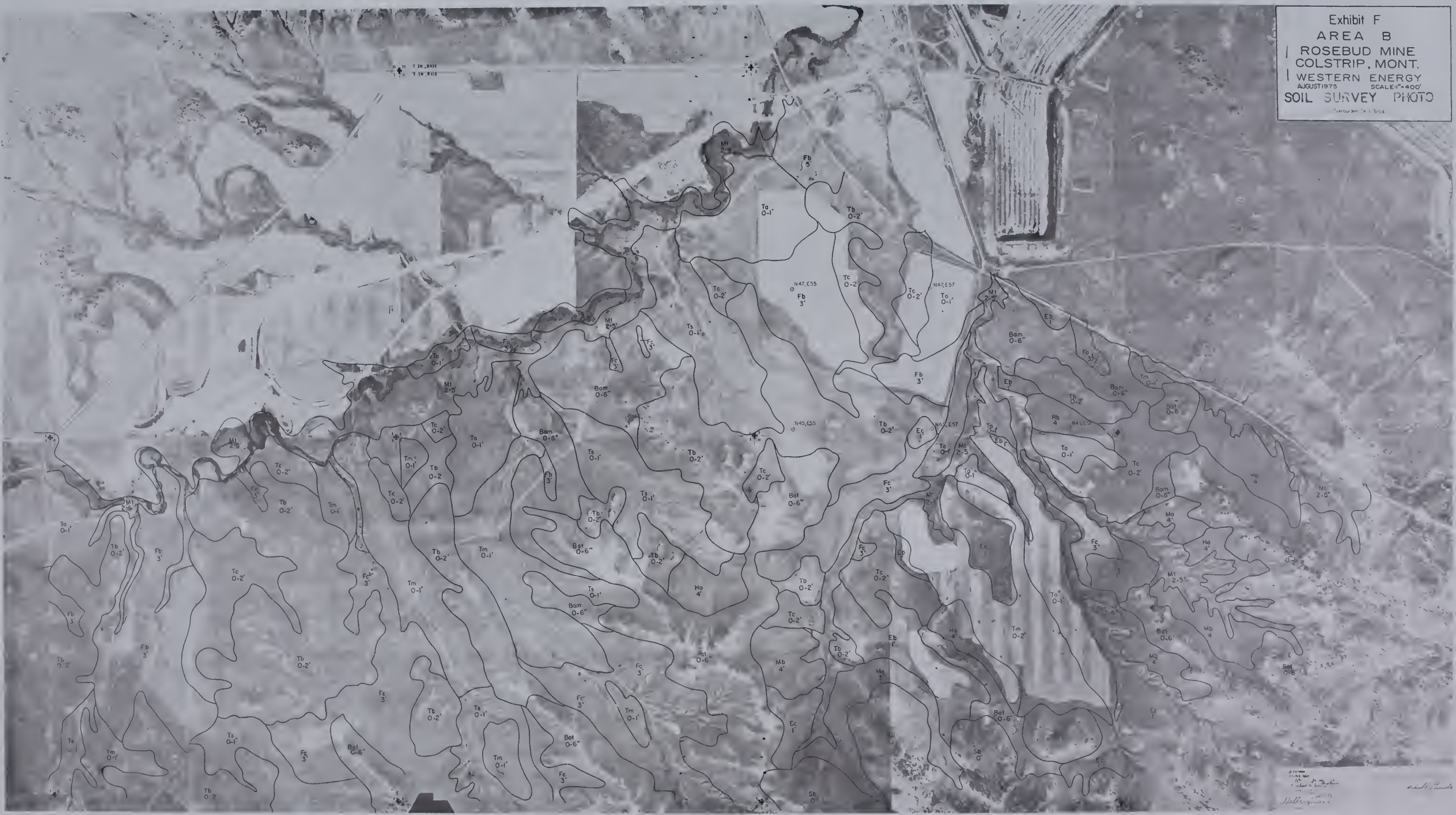


Exhibit F
AREA B
ROSEBUD MINE
COLSTRIP, MONT.
WESTERN ENERGY
AUGUST 1975 SCALE: 1" = 400'
SOIL SURVEY PHOTO
Overburden Drill Sites

Table 11: Soil types and respective salvage depths for Area B. *

Map Symbol		Depth in Feet Suitable for Stockpiling	
Bam	Bainville-Midway Complex 4-20	0-6"	
Bat	Bainville-Midway Complex 15-50% Slope	0-6"	
Ec	Bainville-McRae Loams, 15-35% Slope	1	
Eb	Bainville Loam 4-15% Slope	1	
Fa*	Fort Collins Loam 0-2% Slope	Up to 3½'	c
Fb*	Fort Collins Loam 2-4% Slope	Up to 3'	
Fc*	Fort Collins Loam 4-8% slope	Up to 3'	
Ha*	Heldt Silty Clay Loam, 2-8% Slope	4	b
Ma*	McRae Silty Clay Loam, 2-8% Slope	4	a
Mb*	McRae Loam 2-8% Slope	4	a
Mt*	McRae Loam 15-35% Slope	2-5	a
Rb*	Remitt Fine Sandy Loam, 2-8% Slope	4	a
Sb*	Red Rock Outcrop Complex, Steep	0	d
Ta*	Thurlow Clay Loam 0-2% Slope	0-1'	e
Tb*	Tullock Fine Sandy Loam, 2-20% Slope	0-2'	c
Tc*	Tullock Fine Sandy Loam, 4-15% Slope	0-2'	c
Tm	Thurlow Silty Clay Loam, 2-4%	0-1'	e
Ts	Thurlow Silty Clay Loam 4-8%	0-1'	e

(a) Suitable for stockpiling below 5' as deep as the material remains basically the same.
(b) These soils are of clayey texture but when mixed with other lighter textured soils are suitable for stockpiling.
(c) Suitable for stockpiling below 3' as deep as the material remains basically the same.
(d) Unsuitable for stockpiling.
(e) Soluble salts present below 18 inches.

*Source: WECo Surface Mining Permit Application for Area B.

Thicknesses of soil appropriate for stockpiling vary considerably throughout the extent of Area B, ranging in depth from 0-5$^+$ feet. Soils of the upland areas, which formed in place, tend to be shallow and sandy, with coarse sandstone fragments in the thinner sections. Upland soils are represented by the Bainville-Midway Complex, formed on sandstone and shale; and the somewhat thicker Tullock series, formed on sandstone.

Thicker sequences of soil are associate with alluvial fan and terrace deposits carried from the higher areas. Source materials for these deposits comprise sandstone, siltstone, and reworked loam.

The soil series formed from these alluvial deposts are, for the most part, sandy loams, loam, and clay loam, all of which can provide some material suitable for stockpiling.

Not all horizons should be salvaged, however, as some material is nonconducive to successful plant growth. Thurlow soils, in particular, are least desirable because of their heavy clay texture and layers of high salt hazard.

The Heldt and Fort Collins Series contain horizons with high clay content but remain suitable for revegetation, having, on the whole, loam textures. The McRae soils also have loam texture but are distinguished from the Fort Collins and the Heldt soils by being more calcareous. Remitt soils comprise fine sandy loams, being formed on wind-carried sands and sandy alluvium, and would have improved tilth by the addition of clay loam.

Analyses of overburden and innerburden by Northern Testing Laboratories are presented in the Appendix C. The purpose for obtaining such data is to identify any layers with such a characteristic be identified, the Department may require either that it be buried by other spoil material below the rooting depth or, if the hazard is not severe, thoroughly mixed with other spoils.

Soil chemical parameters of primary interst are salt hazard, sodium concentrations, and trace element concentrations. A salt hazard is normally considered to occur at an electrical conductivity of four mmhos/cm (saturation extract). While sodium is a potentially toxic element, (it may, for example, cause a deficiency in calcium uptake by plant tissue), its effect upon soil tilth is more significant. High concentrations of sodium may cause the soil to disperse, thereby adversely affecting its permeability. A measure of the likelihood of such an undesirable effect is the sodium absorption ratio (SAR) defined as: $\frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$

A "red flag" SAR value would be about 10, but this parameter must also be interpreted with regard to absolute ion concentration, soil texture and clay mineral content.

There is considerable uncertainty regarding the levels at which individual trace element concentrations should be regarded as toxic. Levels adopted by the Department for some of the more significant elements are (in ppm): boron - 5, selenium - 2, zinc - 40, lead - (ph<6) 10-15, (Ph>6), 15-20, manganese - 60, and iron - 200+.

Overburden layers in Area B that contain potentially hazardous concentrations of individual nutrients or micronutrients are indicated in Table 12. Also included in Table 12 is a column for ammonium levels. Amonia is significant in terms of its potential for groundwater contamination.

Table 12. Analysis of potentially hazardous overburden layers for Area B.

DRILL HOLE	DEPTH	ZINC	CONDUCTIVITY	AMMONIA	TEXTURE
N 45E55	0-10'	48	4.97		
N 45E55	10-20'		5.94		
N 45E55	20-30'	117			
N 45E55	70-80'			25	
N 45E57	0-10'		4.86		
N 45E57	10-20'				Clay
N 45E57	20-30'	44			Silty Clay
N 45E57	30-60'			30	
N 45E57	60-70'			27	

(Table 12 Continued)

DRILL HOLE	DEPTH	ZINC	CONDUCTIVITY	AMMONIA	TEXTURE
N 45E59	0-10'		5.40	31	
N 45E59	10-20'		5.40	21	
N 45E59	20-30'				Clay
N 45E59	60-70'			22	
N 47E57	0-10'		5.94		
N 45E57	10-20'		6.48		
N 45E57	30-40'			25	
N 47E57	40-50'			22	
N 47E57	50-60'			13	
N 47E57	60-70'			20	

6. Hydrology

(a) Surface Water

Surface waters in the Colstrip area include East Fork Armells Creek and its ephemeral tributaries and water in small impoundments constructed in ephemeral drainages. In addition, Rosebud Creek, a perennial stream, follows a course which brings it within about six miles of Area B. Since Area B lies entirely within the drainage basin of East Fork Armells Creek, Rosebud Creek is considered to have little or no significance to this study.

East Fork Armells Creek, in the vicinity of Colstrip, is an intermittent stream experiencing flow in response to snowmelt and rain storms. Peak flows are generally experienced in late winter or early spring during warming periods when snowmelt is rapid. The U. S. Geological Survey has established a streamflow station on Armells Creek, near Forsyth. No data, however, has been published from this station. Armells Creek, at its mouth, has been classified as perennial.[10]

The reach of East Fork Armells Creek, through Colstrip, has been altered, with encroachment on the low terraces near the creek. Newly established trailer courts south of the town impinge on the creek. creating a potential flood hazard for these mobile homes.

Garbage has been thrown into the creek at certain locations of this area. A tributary to East Fork Armells Creek, which drains Area A, has been channelized through a newly constructed housing development.

Maps of alluvial valley floors for 42, 7½ minute quadrangles in Southeastern Montana have recently been published by the USGS.[11] Colstrip area maps have not been published but preliminary exploration of the area by the USGS indicates that East Fork Armells Creek is an alluvial valley floor.[12] Table 13 prepared by the Montana Department of Natural

Resources and Conservation shows the quality of Armells Creek waters. An analysis of this water quality is as follows:[8]

> In the immediate vicinity of Colstrip, this creek is a calcium-magnesium-sulfate type water. However, the remainder of the creek is a sodium-sulfate type water. Waters of the stream are relatively hard and are distinctive in their high specific conductances, and therefore, high dissolved solids concentrations. Magnesium and sodium are dominant cations and sulfate is the dominant anion. Chloride is present in low concentrations and the bicarbonate ion is of secondary importance. Iron and manganese concentrations commonly exceed U. S. Public Health Service drinking water standards. Other trace elements including copper, zinc, chromium, colbalt, vanadium and boron have been identified in the stream.
>
> In general, the quality of water in Armells Creek may be described as poor. However, this quality improves downstream in the creek with marked reduction in the concentration of dissolved minerals. Specific conductances range from near 5,000 micromhos/cm in the stream's headwaters to near 1,000 micromhos/cm at its mouth during periods of above average flow runoff conditions. During periods of normal or low flow, conductivities in both the headwaters and near the mouth are significantly higher than during periods of above average runoff.
>
> Generally, turbidity and suspended sediment concentrations are low to moderate and generally increase in a downstream direction.

Waters of Armells Creek are used for stock water purposes and perhaps for flood irrigation. No systematic basinwide study has been made of these uses.

Little data is available on ephemeral tributaries to Armells Creek. The U.S.G.S. has installed a crest gage on a tributary, thirteen miles north of Colstrip. This tributary has a drainage area of 1.87 square miles and experienced a peak flow of five cfs in water year 1974. The hydrology of ephemeral streams is so variable that only a long record can establish an accurate predictable record of flow frequencies.

There are several stock ponds and small reservoirs in the vicinity

TABLE 13 - ARMELLS CREEK WATER QUALITY*

Sampling Site Designation	Sampling Site Location *	Dates Sampled	Flow (cfs)	Temperature (°C)	pH (S.U.)	Specific Conductance umhos/cm @ 25° C	Calculated Dissolved Solids (mg/l)	Dissolved Oxygen DO (mg/l)	Biological Oxygen Demand BOD (mg/l)	Fecal Coliform (counts/100 ml)	Calcium Ca (mg/l)	Magnesium Mg (mg/l)	Sodium Na (mg/l)	Potassium K (mg/l)	Total Hardness $CaCO_3$ (mg/l)	Bicarbonate HCO_3 (mg/l)	Carbonate CO_3 (mg/l)	Alkalinity $CaCO_3$ (mg/l)	Sulfate SO_4 (mg/l)	Chloride Cl (mg/l)	Fluoride F (mg/l)	Nitrate NO_3 (mg/l)	Phosphate PO_4 (mg/l)	Iron Fe (mg/l)	Manganese Mn (mg/l)	Zinc Zn (mg/l)	Copper Cu (mg/l)	Cadium Cd (mg/l)	Lead Pb (mg/l)	Arsenic As (mg/l)	Mercury Hg (mg/l)	Chromium Cr (mg/l)	Sodium Adsorption Ratio SAR	Laboratory Turbidity (JTU)	Total Suspended Solids TSS (mg/l)
ells Creek Fork at lstrip	01N 41E 03BB	10/24/73	0.2		8.20	3850	3679				285	362	272		2200	644	0	528	2078	38	.33	0.45	0.86	0.40		0.04	<.01	<.01	0.01	<.01			2.5	1	
	01N 41E 03BB	1/25/74	0.05	2.0	7.21	2826	2584	1.9	1.9	0	261	220	160		1555	602	0	494	1328	12.8		0.78	0.28	2.7	3.0	0.06	0.01	<.01			<.001		1.8	19	19.0
	01N 41E 03BB	4/16/74	0.2	11.8	7.81	3055	2845	10.7	2.4	0	228	281	173		1728	599	0	491	1563	0.2	.30	0.04	<.03	0.41	1.5	0.03	0.01	<.001			<.001		1.8	4	7.2
Fork N of lstrip	03N 41E 28CC	1/14/74	0.9	4.1	7.97	5043	4885	12.5	5.0	1	207	487	525		2520	592	0	485	3048	26	.27	0.19	0.09	0.78	0.51	0.02	0.01	<.01	<.01		<.001		4.6	11	26.0
	03N 41E 28CC	4/16/74	2.0	15.0	8.10	4858	4686	11.9	2.8	36	248	452	488		2460	558	0	458	2904	35	.22	0.0	<.03	0.38	0.18	0.01	0.01	<.001			<.001	0.02	4.3	8	18.0
Fork at Hwy 31	04N 40E 22CA	1/25/74	2.8	2.2	7.98	2096	1639	10.5	4.0	0	124	91	228		682	285	0	214	891	20		0.75	0.11	0.08	<.01	<.01	0.03	<.01			0.001		3.8	2	1.8
	04N 40E 22CA	4/16/74	2.2	24.0	0.31	4460	4002	8.0	1.7	0	216	212	669		1412	506	0	419	1286	9.0	.31	0.18	0.03	0.34	0.21	0.01	0.03	<.001			<.001		7.7	20	28.0
pper West Fork	03N 39E 26AC	4/14/74	1.6	15.0	8.20	5440	5026	9.50	1.5	6	192	301	888		1720	640	5	533	2999	0.2	.27	0.0	<.03	0.25	0.07	0.01	0.01	<.001			<.001		9.3	17	16.8
Fork nr Hwy 315	04N 40E 16AB	1/25/74	3.1	2.0	7.92	3272	2769	11.0	4.4	0	167	132	468		962	412	0	338	1570	17.8		1.6	0.17	0.39	0.26	<.01	0.02	<.01			<.001		6.6	2	10.5
	04N 40E 16AB	4/15/74	2.8	11.6	8.16	4190	3604	11.3	4.0	190	176	164	675		1116	522	5	436	2049	12.0	.44	0.0	<.03	0.65	0.15	0.01	0.01	<.001			<.001	0.04	8.8	18	28.0
t Highway 315	05N 39E 36BB	1/25/74	4.5	0.0	7.96	2280	1735	11.7	6.0	0	104	68	323		540	318	0	261	908	13.3		0.66	0.11	0.61	0.20	0.01	0.01	<.01			0.004		6.0	15	37.3
	05N 39E 36BB	4/16/74	4.2	13.5	8.21	3210	2634	11.3	3.6	32	124	97	538		710	413	0	339	1444	17.0	.27	0.06	0.03	0.35	0.33	0.02	0.01	<.001			<.001	0.05	6.8	36	38.0
of Forsyth	06N 39E 23AC	12/14/73	1.9	3.1	8.32	3880		13.3	2.1	2														0.16		0.02	0.01	<.01	0.01					8	24.8
	06N 39E 23AC	1/22/74	9.2	0.0	7.80	1006	701	11.6	11.0	1120	62	58	138		178	194	0	159	292	8.2		1.4	0.23	3.4	0.15	0.01	0.02	<.01			0.01		4.5	72	180
	06N 39E 23AC	3/1/74	2.3	4.7	8.18	2914	2301	11.8	4.7	260	63	70	525		447	512	0	420	1118	12.0		0.31	0.49	1.8		0.02	<.01	<.01	<.01	<.01	<.001	0.01	10.8	33	64.0
	06N 39E 23AC	4/16/74	4.2	14.0	8.23	2628	2095	11.0	3.5	212	92	67	441		504	380	0	312	1100	14.0		0.27	0.06	1.8	0.21	0.02	<.01	<.001			<.001	0.05	8.5	43	93.0
	06N 39E 23AC	4/17/74	4.2	13.5	8.31	3304	2796	10.9	3.6	50	99	99	606		656	463	6.0	389	1500	23													10.3	26	64.0
	06N 39E 23AC	6/20/74	18.3	27.2	8.21	650		8.4			39	13	82		152	134	0	110	204	5.5		0.55	0.17	9.2	0.32	0.03	<.01	<.001		.005	<.001	0.01		270	380

*Reference: Montana Department of Health and Environmental Sciences as reported in Montana Department of Natural Resources and Conservation 1974. Draft Environmental Impact Statement on Colstrip Electric Generating Units 3 and 4, 500 kilovolt Transmission Lines and Associated Facilities, Helena, Montana.

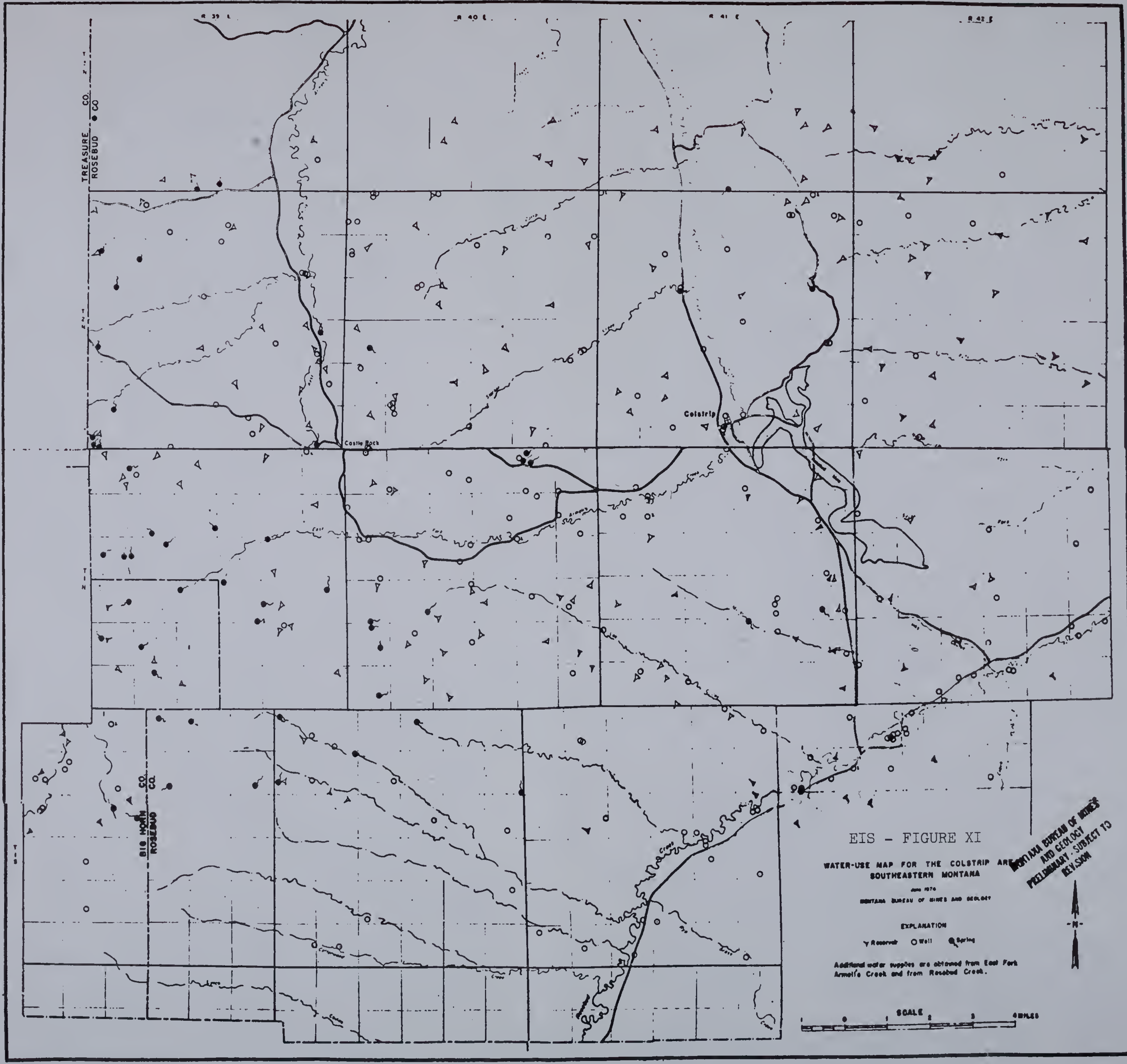
of Colstrip. These are identified on the water use map (Figure XI). Many of these ponds hold water year around and serve as important stock water sources in summer. Evaporation and seepage have been shown to be major sources of basin wide water loss from stockwater reservoirs in Wyoming.[13] Water lost by evaporation is lost entirely from the system while seepage losses can contribute to downstream groundwater groundwater recharge and streamflow. In the Upper Cheyenne basin of Wyoming, it was found that about a 40 percent water loss was chargeable to stock ponds.[13] No water quality data is available on Colstrip area stock ponds.

(b) Groundwater

Groundwater investigations have been conducted in the Colstrip area in conjunction with mineral resource investigations,[14] power plant impact analysis,[8, 15] and strip coal mine impact analysis.[16] Continuing study in the area, primarily by the Montana Bureau of Mines and Geology, has updated these earlier studies.

Most use of groundwater in the area is from shallow aquifers within 600 feet of the surface. At the town of Colstrip, two wells used for **alternative** public water supply extend to the Hell Creek formation (well depth 1,520 feet) and to the Madison formation (well depth 9,336 feet). These deeper aquifers are the most dependable groundwater sources in the area, however, development costs have precluded their widespread utilization.

Significant shallow aquifers in the Colstrip area are alluvial deposits comprising the valleys of East Fork Armells and Rosebud Creeks, sand and coal beds of the Tongue River Member of the Fort Union formation, and sand beds in the Tullock Member of the Fort Union.



EIS - FIGURE XI

Additional water supplies are obtained from East Fork Armell's Creek and from Rosebud Creek.

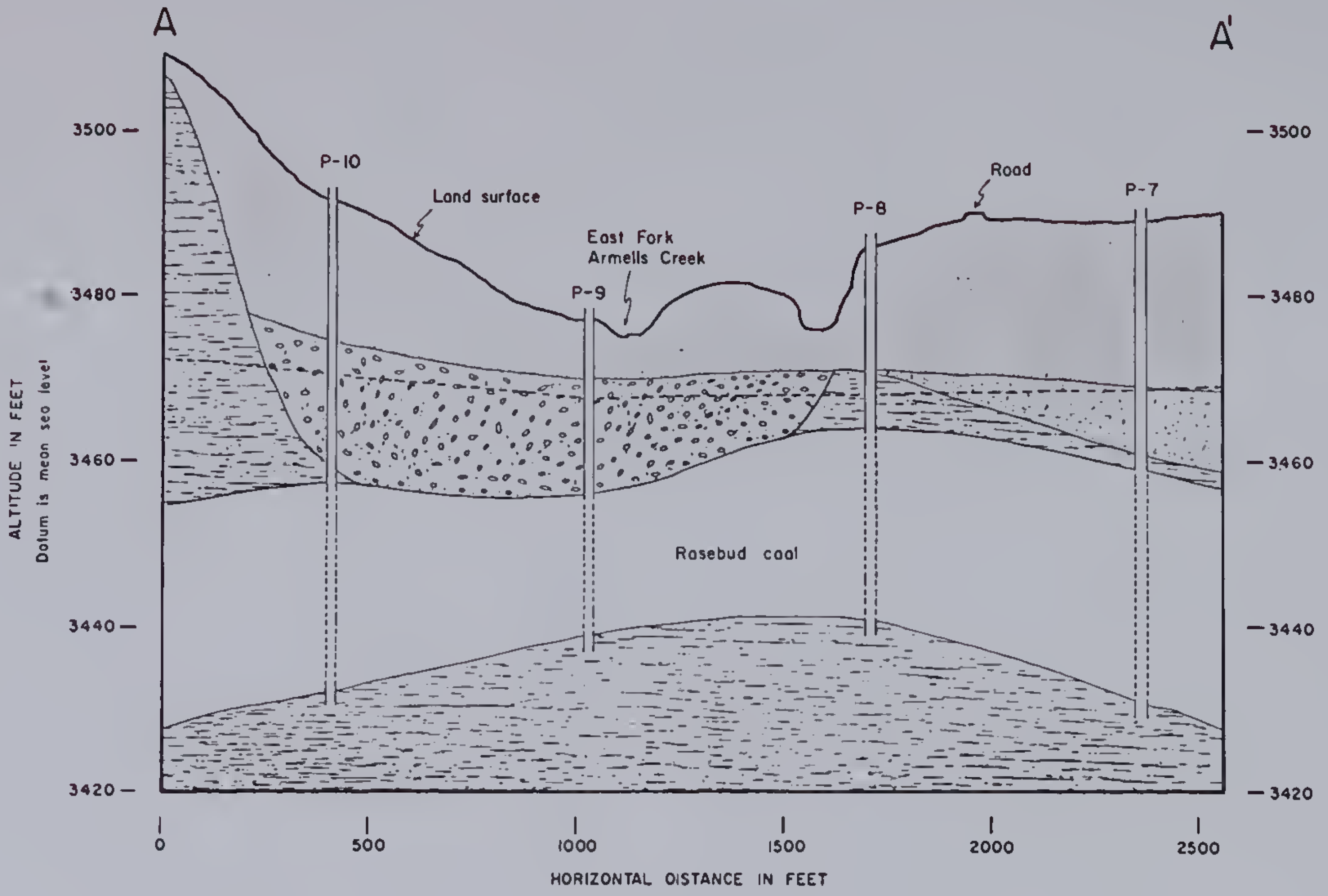
MONTANA BUREAU OF MINES AND GEOLOGY PRELIMINARY. SUBJECT TO REVISION

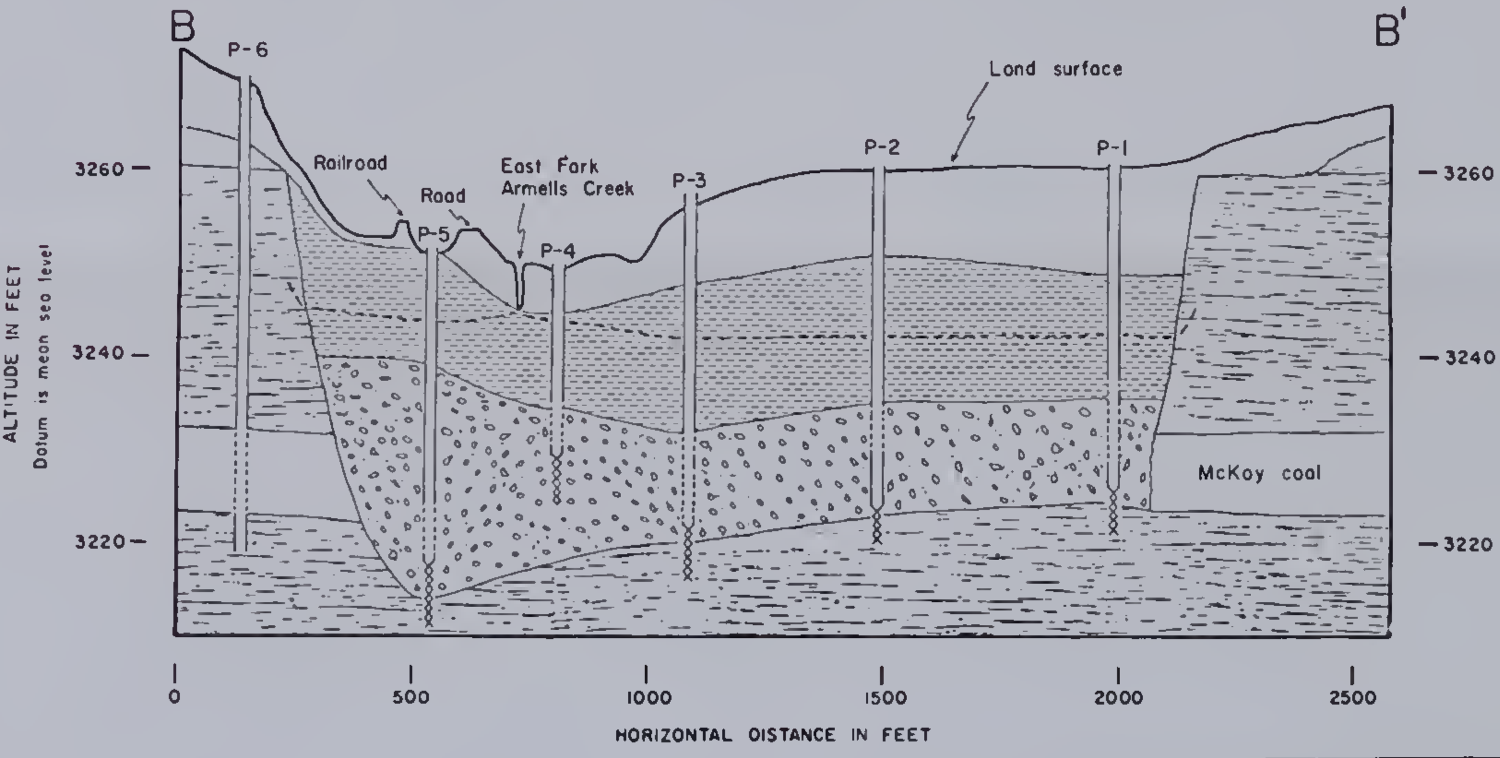
Van Voast has constructed observation wells at three locations across East Fork Armells Creek[17] (Figure 12). Drilling data shows that the valley fill is comprised of between 30 and 40 feet of material - predominately gravel at the base, overlain by clay and then by silt. Groundwater is found in the gravel under slightly confined conditions. Upstream of Colstrip, water levels are generally below the elevation of the channel bottom, however, downstream of Colstrip, several reaches of the creek carry groundwater flow year round and are a dependable stock water source. Groundwater in the alluvium is recharged from bedrock aquifers which outcrop and subcrop the valley fill and by stream flow during the time that it occurs.

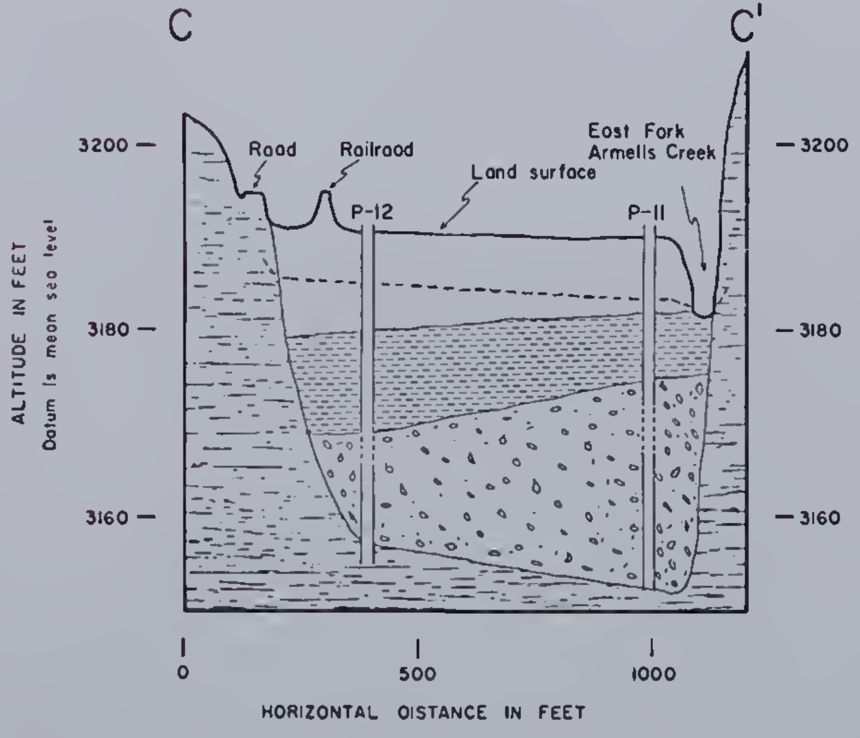
Sand and coal beds comprise the shallow bedrock aquifers. Coal is not considered a permeable substance, but beds in the Fort Union formation are rendered permeable by fracture that provide minute openings which store and transmit water. Some areas of the coal beds are so unfractured, however, that they are essentially dry. Sandstone units may provide good sources of water, however, individual beds are not usually laterally continuous over wide areas.

Acquifer tests have been conducted by Van Voast.[18] Table 14 indicates the great variation in permeability of coal beds. Transmisivity values for the Rosebud coal range from 0.04 M^2/day to 160 M^2/day. East Fork Armells alluvium has the highest transmissivity values in the area. Van Voast defines transmissivity as follows:[19]

> "Transmissivity" is used to indicate the ability of an aquifer to transmit water and is equivalent to the hydraulic conductivity multiplied by the aquifer thickness in feet. Transmissivity is defined as the flow of water in cubic feet per day through a section of aquifer one foot wide under a hydraulic gradient of one foot per foot .







EIS - FIGURE XII

HYDROGEOLOGIC PROFILES ACROSS EAST FORK ARMELLS CREEK NEAR COLSTRIP, SOUTHEASTERN MONTANA

Montana Bureau of Mines and Geology December 1975

EXPLANATION

UNCONSOLIDATED MATERIALS

- ▨ Clay
- ☐ Silt
- ☐ Sand
- ▨ Gravel

CONSOLIDATED MATERIALS

- ☐ Coal
- ▨ Clay and silt

- P-e Observation well
- Perforated casing
- Drilled but not cased
- Piezometric surface August 26, 1975

ORIENTATION OF PROFILES 'A', 'B', AND 'C'

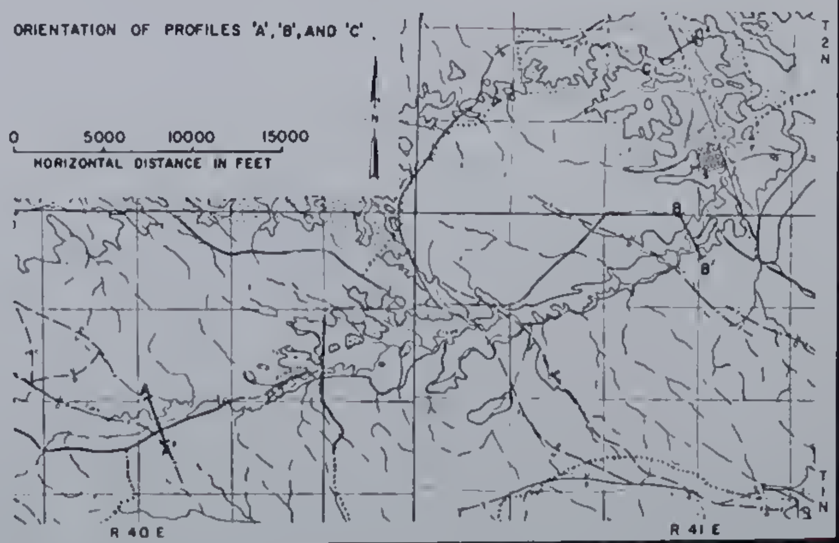


Table 14. Preliminary Colstrip aquifer test data(a)

Hole No.	Location	Aquifer	Transmissivity (m^2/day)	Hydraulic Conductivity (m/day)
P-2	1N41E04AADD	Alluvium	170	46
S-19	$1N41E16BAB_2$	Rosebud	1.7	0.2
S-23	$1N40E13CCDC_2$	Innerburden	4.3	0.4
S-24	$1N40E13CCDC_3$	Rosebud	0.4	0.05
S-27	$1N41E10AACD_1$	McKay	0.2	0.1
S-28	$1N41E10AACD_2$	Rosebud	160	21

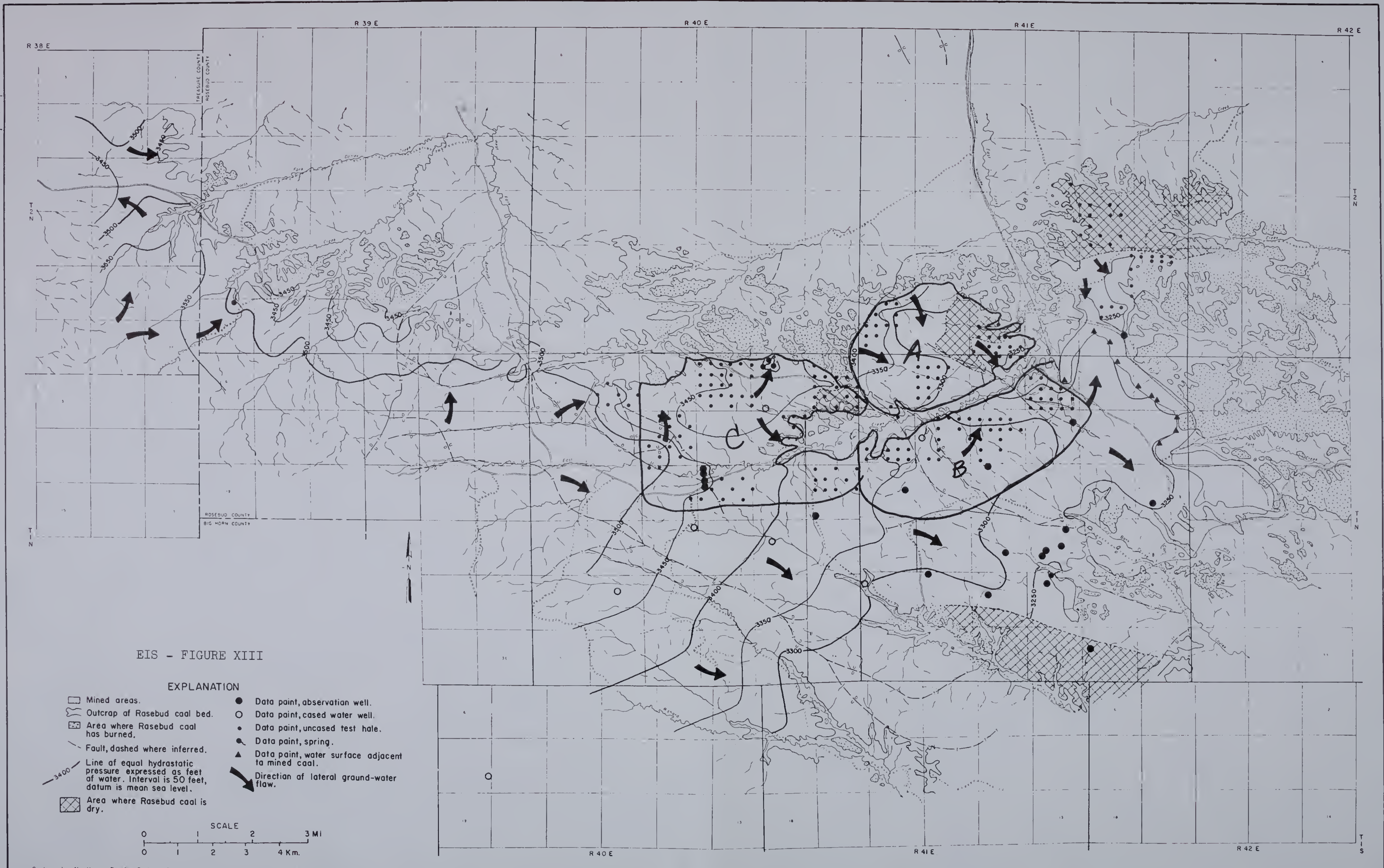
(a) Source: August 5, 1975 letter from Wayne Van Voast, Montana Bureau of Mines and Geology, to Mike Grende, Permit Supervisor, WECo, in reference to Supplement A requirements for WECo's Area A Surface Mining Permit.

Lateral flow patterns for the Rosebud Coal bed are shown in Figure 13. As discussed by Van Voast, flow directions are controlled by the structural gradient and by the outcrop geometry of the aquifer.[16] Some of the faults mapped in Figure 13 may also influence flow patterns. Van Voast continues:[16]

> The aquifer is recharged laterally from the west and vertically from above. Discharge is laterally eastward to the outcrops and to East Fork Armells Creek, and vertically downward to stratigraphically lower aquifers. Along most of the outcrops, discharge rates are not great enough to produce usable supplies of water. Exceptions are springs in Sec. 31, Twp. 2N, Rge. 39E, and Sec. 2, Twp. 1N, Rge. 40E, and seepage to the Rosebud Mine.

Figure 13 is generally applicable to overlying aquifers (except alluvium) and underlying aquifers of the Fort Union formation. Overlying aquifers would exhibit flow lines more strongly controlled by outcrop patterns while underlying aquifers would show less control by outcrops.

Van Voast's examination of well depths and water-level elevations


R 38 E
R 39 E
R 40 E
R 41 E
R 42 E
T 2 N
T 1 N
T 1 S
TREASURE COUNTY
ROSEBUD COUNTY
BIG HORN COUNTY
N
A
B
C
3500
3450
3400
3350
3300
3250
EXPLANATION
Mined areas.
Outcrop of Rosebud coal bed.
Area where Rosebud coal has burned.
Fault, dashed where inferred.
3400 Line of equal hydrostatic pressure expressed as feet of water. Interval is 50 feet, datum is mean sea level.
Area where Rosebud coal is dry.
Data point, observation well.
Data point, cased water well.
Data point, uncased test hole.
Data point, spring.
Data point, water surface adjacent to mined coal.
Direction of lateral ground-water flow.
SCALE
0 1 2 3 Mi
0 1 2 3 4 Km.

EIS - FIGURE XIII

Geology by Northern Pacific Railway Company, V W Carmichael, 1964, Sec & twp grid from 1" = 1 mile scale Mont. Hwy. Dept county maps (1962) Geologic interpretation, drainage, and culture from 1957, SCS 1:20,000 scale aerial photography

indicates decreasing hydrostatic head with increasing depth to aquifer in most of the area.[16] This implies a general trend of downward leakage of groundwater from the overlying aquifers. The only exceptions to this pattern are along East Fork Armells and Rosebud Creeks.

Quality of groundwaters in the Colstrip area varies greatly, in terms of both degree of mineralization and chemical type. Specific chemical types do not correspond with specific aquifers or localities.

Van Voast summarizes the water quality for the Colstrip area as follows:[16]

> In general, the least mineralized waters, that is, those that contain less than about 1,000 mg/l (milligrams per liter) dissolved solids, are those in which calcium, magnesium, and bicarbonate are the principal constituents. Most waters in the area contain magnesium, calcium, and sulfate as principal constituents. Dissolved-solids concentrations found for these waters extend over a wide range (about 1,000 to 5,600 mg/l). In a third chemical type of ground water, sodium sulfate water, the dissolved-solids concentration ranged from about 2,000 to 3,500 mg/l.

Figure 11 shows wells and springs in the Colstrip area. Appendix D lists these wells and springs and the stratigraphic position of the aquifer tapped. Van Voast summarizes local ground water use as follows:[16]

> "In township tiers 3 North (part) and 2 North, most wells and springs obtain water from aquifers stratigraphically below the McKay coal bed. Most of these sources are sandstone aquifers near the base of the Tongue River Member and the top of the Tullock Member of the Fort Union Formation. In township tiers 1 North and 1 South, aquifers stratigraphically below, between, and above the strippable coal beds are all heavily relied upon as sources of ground water. Yields of most wells are less than about ten gallons per minute but are adequate for most stock and domestic needs. Yields as great as about 50 gallons per minute have been obtained for the town of Colstrip from sandstone in the Tullock Member. All springs inventoried near Colstrip supply water for stock. Almost all of them flow less than five gallons of water per minute.

The existing Colstrip environment is comprised of active strip coal mines at Area A and Area E (Western Energy Company) and the Big Sky Mine (Peabody Coal Company). Large areas east of the highway have been previously mined by Northern Pacific Railway in the 1930's and by Western Energy (Pit 6).

Mining of the Rosebud coal in the southern end of Area E has thus far encountered very little water, and no surface discharges of pit waters have been made. Little effect on the groundwater system is expected.[17]

Mining of the Rosebud coal in Area A is also not expected to substantially alter the groundwater system. The coal seam has a very limited recharge area and is consequently dry or partly saturated in the existing and proposed Area A areas.[17]

Groundwater inflow to pits in Area E or A would increase if the McKay coal were mined in either area. In Area A, if active pits extend the entire east/west dimension of the proposed Area A, Van Voast estimates that a maximum of 200 cubic feet per day of water (about one gallon per minute; .002 cfs) could be intercepted from normal flow towards East Fork Armells Creek.[17] Mining of the McKay coal along the edge of East Fork Armells Creek alluvium could cause a reversal of hydraulic gradients inducing groundwater flow from alluvium to the pit. It is doubtful that the induced flow would be great, but the rate would largely depend upon the mine's distance from the McKay subcrop and the degree of fracturing created by coal blasting. At the completion of Area A mining, the prior mining flow pattern would resume, at a rate slightly greater than pre-mining flow rates, due principally to the greater recharge capacity of mine spoils.[17]

In Area E, mining of the McKay coal would increase pit inflows and probably lead to discharges from the mine. Excessive volumes of pit inflows are not expected, however, due to the low transmissivity of the McKay coal (See Table 14).[17]

If the McKay coal is mined, and effluents are discharged to East Fork Armells Creek, it is expected that effluent waters will be chemically similar natural streamflow. Dissolved solids concentrations from most mine areas will be less than 2,000 mg/l. Higher concentrations may occur in effluent from the northeast end of Area E because of induced from old Rosebud mine spoils where dissolved solids concentrations may approach 3,000 mg/l.[17]

Both the Rosebud and the McKay coal beds are mined at the Big Sky mine. Most pits have intercepted little groundwater. Substantial flows, however, have recently been intercepted with the initiation of mining in Miller Coulee (1N and 1E, 22, 23) where substantial flow has been intercepted from both coal beds, Rosebud overburden, and alluvium. Peabody is presently pumping between 0.5 and 1 million gallons/day from this pit, opened in early February, 1976. Although upgradient drawdown impacts have not yet been detected, they will be an inevitable impact of these large pit inflows.

B. Biological Environment

1. Vegetation

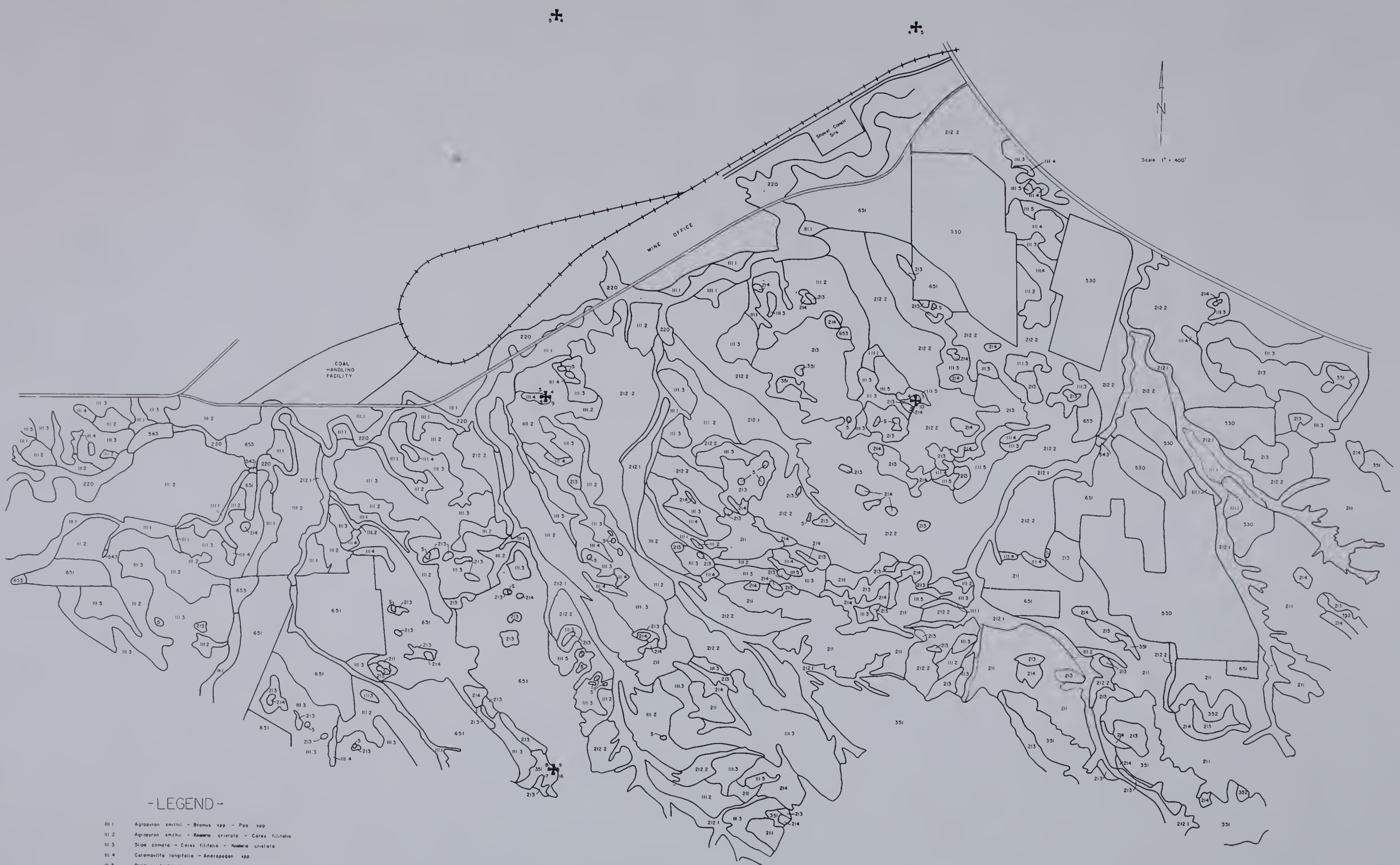
Kuchler described the Colstrip area as an eastern ponderosa pine formation.[20] Subsequent site specific studies by Sindelar[21] and Environmental Consulting Service[22] have described 7 and 20 vegetation community types, respectively. Although Sindelar's was the only study to address Area B vegetation separately, the ECS Community types will be used in this impact statement as they are the types delineated on WECo's permit application vegetation map (Figure XIV). Plant community descriptions are given in Appendix E.

Of the twenty vegetation communities described by ECS, eighteen are found in the subject permit area.

Five of the seventeen vegetation communities were grassland, five shrub-grassland, three timber grassland and three non-natural plant communities. Table 15 gives the percent of the proposed Area B permit area represented by each of the communities represented. Table 16 gives the range condition classification and stocking rate for eleven of these vegetation types. The ECS study did not address Area B separately, and therefore all acreages and percentages given in Table 15 are derived from planometric measurements, and are necessarily approximate figures.

2. Wildlife

Mule deer (Odocoileus hemionus), white tailed deer (Odocoileus virginianus and antelope (Antilocapra americana) have been observed in Area B in Ecological Consulting Service (ECS) surveys from 1973-1975.[23, 24, 25] Area B, however, does not appear to be as heavily used as surrounding areas.



-LEGEND-

111 1	Agropyron smithii - Bromus spp - Poa spp
111 2	Agropyron smithii - Koeleria cristata - Carex filifolia
111 3	Stipa comata - Carex filifolia - Koeleria cristata
111 4	Calamovilfa longifolia - Andropogon spp
111 5	Bromus tectorum
211	Artemisia tridentata - Koeleria cristata - Agropyron spicatum
212.1	Artemisia cana — Agropyron smithii — Stipa viridula — Poa spp
212.2	Artemisia cana — Agropyron smithii — Stipa viridula — Bromus spp
213	Rhus Trilobata — Agropyron smithii — Stipa comata
214	Chrysothamnus nauseosus — Agropyron spicatum — Oryzopsis hymenoides
220	Poa spp. — Agropyron smithii
351	Pinus ponderosa — Agropyron spicatum
352	Pinus ponderosa - Juniperus scopulorum — Agropyron spicatum
530	Agricultural
543	Ponds
651	Disturbed Grassland
652	Roadways
655	Residential
654	Railroads
S	Sandstone Outcrops

EIS - FIGURE XIV

WESTERN ENERGY
VEGETATION MAP AREA B
1975

VEGETATION COMMUNITY TYPE PERCENTAGES FOR AREA B

VEGETATION COMMUNITY TYPE		% OF PERMIT AREA
Grassland Communities		21.4
111.1	*Agropyron smithii* - *Bromus* spp.	4.3
111.2	*Agropyron smithii* - *Koeleria cristata* - *Cavex filifolia*	5.2
111.3	*Stipa comata* - *Carex filifolia* - *Koeleria cristata*	8.9
111.4	*Calamovilifa longifolia* - *Andropogon* spp.	2.1
111.5	*Bromus tectorum*	.9
Shrub-Grassland Communities		50.7
211	*Artemisia tridentata* - *Koeleria cristata* - *Agropyron spicatum*	7.9
212.1	*Artemisia cana* - *Agropyron smithii* - *Stipa viridula* - Poa spp.	7.6
212.2	Artemisia cana - Agropyron smithii - *Stipa viridula* - *Bromus* spp.	25.0
213	*Rhus trilobata* - *Stipa comata* - *Agropyron smithii*	9.0
214	*Chrysothamnus nauseosus* - *Agropyron spicatum* - *Oryzopsis hymenoides*	
Timber - Grassland Communities		2.2
220	*Acer negundo* - *Fraxinus pennsylvanica* - *Poa* spp. - *Agropyron smithii*	1.7
351	*Pinus ponderosa* - *Agropyron spicatum*	.4
352	*Pinus ponderosa* - *Juniperus scopulerum* - *Agropyron spicatum*	.1
Non-Natural Plant Communities		25.5
530	Agriculatural	18.6
543	Stock ponds	.03
651	Disturbed grassland	6.5
653	Residential	.4
	Sandstone outcrop	.08

TABLE 16 - RANGE CONDITION CLASSIFICATION
AND
RECOMMENDED STOCKING RATES
FOR
ELEVEN PLANT COMMUNITIES PRESENT
ON
WESTERN ENERGY MINING AREAS A, B, AND E
COLSTRIP, MT*

Plant Community	Date	SCS Range Site[1]	Condition Classification	Recommended Stocking Rate[2]
Agropyron smithii-Bromus spp.-*Poa* spp. (111.1)........................	9/2/75	Overflow	Good (55)[3]	.60
Agropyron smithii-Koeleria cristata-Carex filifolia (111.2)...	9/3/75	Silty	Fair (47)	.30
Stipa comata-Carex filifolia-Koeleria cristata (111.3)...........	9/3/75	Silty	Fair (32)	.30
Calamovilfa longifolia-Andropogon spp. (111.4)........................	9/3/75	Sandy	Good (70)	.45
Artemisia tridentata-Koeleria cristata-Agropyron spicatum (211)..	9/3/75	Clayey	Fair (31)	.30
Artemisia cana-Agropyron smithii-Stipa viridula-Poa spp. (212.1)....	9/3/75	Overflow	Good (55)	.60
Artemisia cana-Agropyron smithii-Stipa viridula-Bromus spp. (212.2).	9/2/75	Silty	Fair (41)	.30
Rhus trilobata-Stipa comata-Agropyron smithii (213)...........	9/3/75	Sandy	Fair (37)	.30
Chrysothamnus nauseosus-Agropyron spicatum-Oryzopsis hymenoides (214)	9/3/75	Dense Clay	Poor (16)	.10
Pinus ponderosa-Agropyron spicatum (351)......................	9/3/75	Thin-hilly	Excellent (76)	.50
Pinus ponderosa-Juniperus scopulorum-Agropyron spicatum (352)	9/3/75	Thin-hilly	Fair (49)	.25

[1] Follows SCS criteria.
[2] In AUM's/ac. (Animal Unit Months/acre).
[3] Poor = 0-24; fair = 25-49; good = 50-74; excellent = 75-100.

*Reference: Ecological Consulting Service, 1975, Western Energy Vegetation Production, Condition and Community Typing, Mining Areas A, B and E, Helena, Montana.

In general, the Colstrip area is noted for its high mule deer populations. Using doe-fawn ratios, the Department of Natural Resources and Conservation (DNR) rated such populations "excellent."[8] A 1975 survey conducted by the ECS, however, rated the populations as only "fair."[25]

Antelope production is not highly rated for Area B. ECS blames lack of sufficient sage vegetation in the immediate Colstrip vicinity.

The East Fork of Armells Creek bottoms is noted as white tail habitat in the DNR study.[8]

White tailed deer, however, are not abundant in Area B, according to the ECS.

Sharptailed grouse (*Pediocetes phasianellus*) have been observed in the application area as well as in adjacent areas near the East Fork of Armells Creek. According to ECS data, Area B is not used as heavily by Sharptails as adjacent areas. Other locales in the Colstrip area contain large numbers of Sharptailed grouse.

Ring-necked pheasants (*Phasianus colchicus*) have been repeatedly observed north of Area B in areas immediately adjacent to the East Fork Armells Creek. Increased traffic along the country road paralleling the creek, and disturbances caused by dragline erection, shop facilities and WECo's airport runway, may already have impacted the quality of this area as pheasant habitat.

Sage grouse (*Centrocercus urophasianus*) have not been observed in the Area B. Data submitted by WECo indicates this area is poor sage grouse habitat.[23, 24, 25]

Hungarian Partridge (*Perdix perdix*) have been observed near

Area B, though not in it. Since Area B does contain some agricultural, cropland "Huns" probably use the area at times.

Waterfowl have been shown to extensively use the East Fork of Armells Creek immediately to the north of Area B. Mallards (*Anas platyrhynchos*), pintails (*Anas acuta*), gadwalls (*Anas strepera*), widgeons (*Mareca americana*) and shovelers (*Spatula clypeata*) have been observed in the creek bottoms.

As the East Fork Armells Creek is not a perennial stream, no fisheries exist on/or adjacent to Area B.

A complete listing of animals observed in the vicinity of Colstrip is given in Appendix F.

C. Human Environment

Coal strip mining in Montana, thus far has been limited to primarily two counties, Rosebud and Big Horn. This section of the impact statement deals only with Rosebud County since the population impact anticipated by the proposed expansion of WECO's mine at Colstrip will center in the towns of Forsyth and Colstrip. Table 17 prepared by WECO shows the number of current mining employees at the Rosebud Mine and their present residence.

Table 17 --Number of employees and employee residences for the Rosebud Mine, February, 1976[(a)]

COMPANY	NUMBER OF EMPLOYEES	RESIDENCE
Long Construction Co.	181	Colstrip
	46	Forsyth
	7	Rosebud
	7	Miles City
	7	Billings
	3	Lame Deer
	3	Hysham
	3	Ashland
	4	Other
	262	
Western Energy Co.	8	Colstrip
Total	270	

(a) Source: Letter from Mike Grende, Permit Supervisor, WECO to Charles van Hook, Department of State Lands, February 18, 1976.

It is no longer possible to describe the existing human environment for Forsyth, Colstrip, and to a lesser extent the rest of Rosebud County without describing the impacts of the recent coal mining boom. Such mining has already significantly stressed the social structure and social services in these areas and as the following pages show, resultant changes in this human environment are occurring. The socioeconomic environment impacts resulting from WECO's proposed expansion into Area B will function to maintain and in some instances accelerate the changes which began to occur with the reopening of the Rosebud Mine in 1968.

Three primary references were used for preparing the sections of this EIS dealing with the human environment. These included: "A Comparative Case Study of the Impact of Coal Development on the Way of Life of People in the Coal Area of Eastern Montana and North Eastern Wyoming" by Raymond Gold,[26] "Environmental Baseline Studies for Crow Indian Leases, Socioeconomic Report" by Mountain West Research Incorporated[27], and "Anticipated Effects of Major Coal Development on Public Services, Costs and Revenues in Six Selected Counties" by the Northern Great Plains Resources Program.[28] Extensive sections were taken from these three reports, often times as a direct quotation. Choosing what information to include in this EIS was a difficult task. Where sections appear to be in need of expansion or clarification, the reader is encouraged to read the full reports as referenced.

1. Demographics

Since 1970, the population changes in Rosebud County have been most dramatic. The population is estimated to have risen from 6,032 to about 10,000, an increase of approximately sixty-six percent. Colstrip's population has increased by 3,125 from 75 in 1970 to 3,200 this past summer (1975), and Forsyth's population is estimated at 3,000, an increase of nearly 1,200 people.[27]

This contrasts sharply with the previous trend of population losses established in the prior twenty year period. From 1950 to 1960, Rosebud County lost 5.8 percent of its population and from 1960 to 1970 population declined by 2.5 percent.[27]

2. Land use

Rangeland is by far the most common land use in Rosebud County. Agricultural and forested lands comprise 88.9 percent of the total county acreages. Urban and built-up areas are almost negligible in relation to total county acreages comprising .2 percent in 1967.[27]

3. Local economy

Prior to the resumption of Colstrip mining in 1968, the economy of Forsyth was dependent on agriculture, primarily ranching, and even today remains a low population density, agricultural area. The economy of Colstrip has for its entire existence been for all intent and purposes entirely dependent on coal mining.

Forsyth is experiencing an economic boom from the construction and mining activities at Colstrip and from local railroad expansion being done to accomodate coal shipping needs; 1975 was an outstanding year for agriculture and this also contributed substantially to the local economy. Trailer courts are now much in evidence in Forsyth due to sudden housing shortages. A shortage of labor also exists at all levels. Business however is excellent. People in Forsyth and in neighboring towns for the most part perceive that the price of everything seems to be rising incessantly; hence the value of increased earnings are being eroded.[26]

Demand for land has also created a severe shortage for small acreages. Many newcomers desire one-half acre to fifteen acre spreads, where they can put a trailer house, erect a chicken coop, keep a horse or simply let the dogs run loose. There is no set price for these smaller pieces of land; in fact, nobody wants to sell. One real estate agent is trying to interest ranchers in subdividing but so far has not been successful. Houses in Forsyth, when available, are selling for a third more than they sold for three years ago. The only viable alternative for the present, is for new residents to live in crowded trailer courts until land is available.[26]

As would be expected, the increases in land values have also been accompanied by increases in rents and taxes. Older persons who have lived in the area for decades, have found not only that their property values have increased substantially but that also there is no inexpensive housing to move into should they decide to sell their present residence. Property taxes are almost certain to continue to rise which will perhaps eventually force many to sell when they can no longer meet these and other rising homeowner costs on a retirement income. Property tax in Rosebud County increased fifteen mills in the last year, in spite of a gain of about $1.5 million in taxable property value.[26]

4. Social structure

The Colstrip-Forsyth area is in a state of rapid transition. The influx of newcomers is forcing urbanization onto a traditionally rural area. While economic benefits are often welcomed by the merchants of the impacted areas, there are also attendant social costs involved in coal development which must be dealt with. Businessmen are often left out of the planning processes of the coal companies and therefore realize that they really have very little influence in developmental decision-making processes which significantly affect the character, scope, and security of their businesses. The businessmen of Forsyth view the coal boom as an extended tourist season, which is bound to be over before too much longer. The locals do not act as catalysts of social change, rather new people, used to the amenities of urban living, make demands for goods and services which places a strain on the existing community.[26]

Few ranchers believe that ranching and mining can go on side by side. Ranchers are keenly aware of the tremendous power, both financial and political, held by the industrialists, who are in a position to stifle a productive ranching operation virtually overnight. Competition from the coal companies prevent ranchers from expanding their land holdings while at the same time reducing the attractiveness of their own land to potential buyers aware of the ramifications of coal development. Many landowners no longer feel that they control their own destinies. Montana ranchers tend to view ranching as a way of life rather than just a business.[26]

Gold found that:[26]

> There is a particular irony in the

> feeling among the WASP-like anti-development ranchers that they are rapidly becoming a persecuted minority in the wake of coal development. For years they have been considered prototypical rural Americans, the backbone of the country. Now, suddenly, they are being accused of standing in the way of "progress" (i.e., industrialization of their area). Needless to say, they are in process of undergoing a radical change in status which they find both befuddling and outrageous.

Conflict situations arise when newcomers make demands on facilities for recreational and instructional purposes that they have not, and probably will not pay for, much to the annoyance of the locals. Landowners find themselves subsidizing coal development through increased taxes whether they support it or not. But at the same time, landowners won't sell land to newcomers to pay taxes on.

Gold continues:[26]

> Outsiders see the land as expendable, and dedicated ranchers sense that these people also look upon them as expendable and place a low value on the Western way of life. The ranch offers freedom, absence of regimentation, isolation, and quiet. Coal development threatens all these as well as the aesthetics of the area. Most of these ranchers feel that a demented value system is being imposed upon them and that their Western hospitality and trust is being

violated. For example, newcomers do not have the same respect for the land as do the ranchers, who are more bewildered than angry about the abuses to which their property has already been subjected by the influx of sloppy and careless trespassers. Many newcomers do not understand that a large piece of land is just as private as a fifty-foot lot and act as if these ranches are public property.*

Aside from having to deal with a great many new people who have a foreign set of values, committed ranchers are beset by a number of other difficult aspects related to coal development--aspects which have put them in a very vulnerable position. First of all, neighboring ranchers are highly interdependent and together comprise a fragile social system which is in danger of collapsing if only one or two ranchers sell out. Commenting on the fragility of the situation,

---

*There are a few newcomers who want to earn enough money to be able to live here the way the ranchers do, and some people who came to the area as miners two or three years ago have adopted the local attitudes. These individuals, however, represent a very small portion of the newcomers. Other persons are also interested in preserving the area. In the words of one informant, "when Easterners buy places out here, they tend to be more resistant to industrialization that we old-timers are."

One informant flatly stated:

> That sums it all up . . . . We need each other in order to survive. Until this coal business entered our lives, we had been acting as though we were good neighbors but we had actually been drifting apart. Now we have to really be good neighbors again or we are going to be easy pickings for the coal people.

For the most part, newcomers have not been accepted into the established social structure. Both they and locals tend to stay apart because of their differing values, interests, and commitments. Newcomers who have common interests get together among themselves, and some have managed to make friends with locals and become accepted. Social life for most newcomers at Colstrip is characterized by a great deal of boredom, simply because there is so little for strangers to do in a small town, especially when one has no private land requiring attention. The lack of housing available and of land to buy is widespread throughout the study area, making living conditions difficult for most newcomers, who find themselves with virtually no alternative to crowded trailer parks or camp sites. There is little privacy or neighboring. They are situated like urban tourists in an unfamiliar rural world.

Coal development does not constitute a burning issue for most oldtime townspeople interviewed in

Forsyth and Gillette. Either their lives are not directly affected by it or what ill effects they do anticipate, such as air pollution, are not feared to grow to an intolerable magnitude. For the most part locals are happy with the economic benefits which have accompanied development and do not feel that their way of life has changed all that much--nor is it expected to unless the population influx really becomes huge, which to date it has not. They are concerned about obtaining an adequate number of professionals, particularly physicians and dentists; maintaining a school system whose quality of instruction will not be eroded in the face of rapidly increasing numbers of new students; and, especially in Montana, safeguarding the area water supply, which is widely feared to be inadequate for meeting projected demands. With the exception of increased prices and taxes, which have created a special hardship for those on fixed incomes, the social impact on townspeople so far has not been particularly unpalatable. Second thoughts about development are growing, however.

5. Social services

The present status and adequacy of capital facilities and their ability to handle increased population growth will influence future settlement patterns, satisfaction of community residents with their communities, and the potential economic impact on local government budgets. The following is a recent inventory of the social services available to Colstrip and Forsyth residents.

a. Housing

(1). Colstrip

Colstrip has a severe housing shortage, and there are long waiting lists for houses, apartments, and trailer spaces.

In July 1975 there were 170 houses, 64 apartments, and 158 trailers in Colstrip. There is also a trailer court operated by Bechtel, which has 624 trailers, and a dormitory that houses 270 construction workers.[27] WECO indicates that the company has constructed 106 single family houses and 68 apartment units at Colstrip.[2] The company has also partially remodeled the existing 61 town-site houses and a 4-unit apartment and have created 3 permanent mobile home parks.

Mountain West Research, Inc., reports that:[27]

> Because Colstrip is a company town, all units are rental. Old houses (2-4 bedrooms) rent for $65-$125; new houses (2-4 bedrooms) rent for $100-$300 per month; apartments (1, 2, and 3 bedroom) are $145-$265 per month; and trailer lots are $50 per month (City Manager, Colstrip, personal communication, July, 1975). In the Bechtel trailer court, lots are $40 per month for a full service lot and $25 per month for the "hobo camp" (Bechtel Rental Housing Office, personal communication, August 4, 1975). Actual costs for individuals are frequently lower, however, as residents are often subsidized by the

companies they work for (City Manager, Colstrip, personal communication, July, 1975). The homes are generally in good condition. The new housing areas and the older part of town are aesthetically attractive, but the huge trailer courts do not provide a pleasant living environment.

New home construction costs range from $22,000 to $32,000 and both stick and modular unit construction methods are used. There is no problem of labor supply, and there are no major problems in obtaining building supplies, although service is sometimes slow since most materials come from Billings.

The company which owns Colstrip is considering expanding the housing areas and possibly selling homes and lots for development in the future. If Units 3 and 4 are approved, the company will probably immediately build 50 more housing units (City Manager, Colstrip, personal communication, July, 1975). It is felt, however, that if Units 3 and 4 are approved, a total of 400 to 600 more housing units will be needed. (Bechtel Rental Housing Office, personal communication, August 4, 1975).

(2). Forsyth

Mountain West Research Incorporated reports that:[27]

Housing estimates for Forsyth vary widely from a low of 846 to a high of 1,250 units. Based on present estimates of population, household size, and water hookups, just over 1,100 units is a reasonable estimate. The distribution of the larger estimate by type are said to be 622 single-family homes, 90 apartments, 210 motel rooms, and 324 mobile homes (Based on 1970 Census Data and Building Permits for Forsyth, 1970); any error in the estimate is most likely to occur in the count of mobile homes. (The motel room figure does not include rooms not used as permanent residences unless over 75 percent of the rooms in the structure are so counted.)

There is a low housing turnover rate in Forsyth, and at present, there are no units for sale or rent. When homes are available, their prices range from $10,000-$60,000, although most are sold for about $35,000. In the past three years, housing prices have increased 50-100 percent depending on whether or not improvements have been made (Tillet Real Estate Agency, personal communication, July, 1975). Rentals range from $60-$70 per month for rooms to $100-$250 per month for houses (County Planner, Rosebud County, personal communication, August, 1975).

Of the single-family housing units' condition in 1970, slightly more than seventy-one percent were classified as below average, fair, poor, or substandard. Only 2.6 percent were considered good, and none were considered excellent ("Housing Rosebud County" prepared by the County Planning Office).

There is little land available for new development in the Forsyth vicinity as most of the surrounding land holders are unwilling to sell. In one area to the southeast where land is for sale, it is going for $1,000 per acre; lots in town, about one-fifth of an acre in size, are selling for $3,000, but there are very few of these lots on the market.

It is also somewhat difficult for new developments to get services. Water and sewer systems in Forsyth are overloaded; for this reason, proposed annexations of developments just outside the city limits have been refused. Private utilities, such as power and gas, are available, but due to the rapid housing increase may take several months to install. The major problem faced by developers, however, is the lack of available financing (County Planner, Rosebud County, op. cit.)

There are two developments currently under construction in the Forsyth area. One is a subdivision for 57 single-family lots in which the utilities are being installed and the lots should be ready for sale within the year (1975). The other development is a 24-unit low-income housing apartment building which should be ready this fall (1975). Another development of 238 mobile home sites has been proposed, and it is believed that the proposal will soon be approved. There is also a piece of property currently for sale on which a developer is proposing to build 32 units; this, however, is tentative (County Planner, Rosebud County, op. cit.). Most of the new housing activity in the past five years as well as that currently proposed is mobile home development.

Forsyth recently passed regulations prohibiting any new mobile homes in the central part of town unless they are converted to permanent residences; this has effectively limited mobile home development to the edge of town. In general, the town would like to promote growth of compact residential areas with good traffic circulation patterns.

b. Water systems

(1). Colstrip

Mountain West Research Incorporated reports that:[27]

Until recently, the water for the Colstrip system was drawn from six wells, which together could pump 140 gpm; there was also a hot water well which could supply 200 gpm (this source is rarely used due to poor water quality). The water from the other wells required no treatment and was pumped directly into the distribution and storage systems. These wells are now used at night to supply water to the system when the treatment plant is shut down and usage is low (City Manager, Colstrip, personal communication, July, 1975). The Yellowstone River is presently the major source of water supply. Due to increasing water needs, the town made an agreement with Montana Power for use of up to 1,000 gpm of the water that the company draws from the river. The town has a total resource of 1,140 gpm, or 1.4 million gallons per day, which is adequate for its present needs.

Colstrip has a water storage capacity for municipal use of 600,000 gallons; an elevated storage tank holds 100,000 gallons and the remaining 500,000 gallons are stored in a reservoir near town (Engineer, Christian-Spring-Sielbach & Associates, Billings, Montana, personal communication, August 6, 1975).

The water from the Yellowstone River requires treatment and is pumped into the water plant where it is filtered, cooled, chlorinated, and softened (City Manager, Colstrip, personal communication, July, 1975). The water from the plant meets state health standards; some of the water from the wells, while safe from a health standpoint, is hard and has a fairly high sulphur content. The town is trying to improve this situation by mixing the well water with water from the treatment plant. The plant is new, in good condition, and has a maximum capacity of 1,000 gpm, or--in a 24-hour

> period--1.4 million gallons (Engineer, Christian-Spring-Sielbach & Associates, Billings, Montana, personal communication, August 6, 1975).

According to the Department of Health and Environmental Sciences, coliform counts in Colstrip waters intermittently exceeded Montana water quality standards for the period from 1972-October, 1974. Since October, 1974, water quality samples have not exceeded the coliform limits, probably due to the initiation of a water chlorination process.

Mountain West Research reports that:[27]

> Colstrip's water distribution system is in good condition except that the old part of town has cast-iron pipes which eventually should be replaced. The lines were originally sized to accommodate expansion of the system so that growth will only require the extension of lines into new areas. The system is entirely looped, and water pressures vary from 35-45 pounds which is a marginal standard (City Manager, Colstrip, personal communication, July, 1975). There are no plans for system improvement unless stiffer water quality standards, now being discussed, are approved. Depending on the final form of these standards, changes in the plant may be required (City Manager, Colstrip, personal communication, July, 1975).

(2). Forsyth

Mountain West Research, Inc., reports that:[27]

Forsyth draws its water from the Yellowstone River. The town has water rights dating from 1908 to 50 cubic feet per second (cfs), or nearly 3,560 acre feet per year, which is ample for present and future population needs. The water is stored in a 330,000 gallon concrete reservoir which is in good condition, although it was constructed prior to 1918. Forsyth's water storage should be increased to 1,320,000 gallons to meet peak day demand and fire requirements.

The water treatment plant was built in 1931, has had little work done on it since that time, and the equipment is wearing out or in need of updating. The plant has a capacity of 1,500,000 gallons per day (gpd). Average use during the summer is about 1,125,000 gpd, and the average use for the year is about 480,000 gpd. A peak day's demand, however, is about 1,800,000 gpd. The plant is in poor condition and nearing capacity, and it is recommended that the city remodel the plant and increase its capacity to 3,000,000 gpd.

Forsyth's water distribution system is adequate although some improvements should be made. A few pipes are cast or galvanized iron, but most of the system is of asbestos or cement pipe which vary from 2" to 8" in diameter. Some 8" mains should be added to the system and some 4" pipes replaced with 6" pipes to improve water circulation ("Preliminary Studies and Report for Water System Improvements," Forsyth, Montana, Morrison-Maierle, Inc., Consulting Engineers, Billings, Montana, November, 1972).

c. Sewer systems

(1). Colstrip

Mountain West Research, Inc., reports that:[27]

Colstrip is served by a three-cell lagoon sewage treatment system which has a total of ten surface acres (City Manager, Colstrip, personal communication, July, 1975). It is estimated that the average sewage output is 825,000 gallons per day (Engineer, Christian-Spring-Sielbach & Associates, Billings, Montana, personal communication, August 6, 1975). The system was originally designed to serve a population of 1,200 or about 120,000 gpd, and is presently over capacity (Engineer, Christian-Spring-Seilback & Associates, Billings, Montana, personal communication, August 6, 1975). So far the system has not discharged any effluent but probably will have to in the future. Colstrip would like to add an oxidizing ditch to further improve the quality of the discharged effluent, a proposal being studied by the State Board of Health and Environmental Sciences prior to issuance of a construction permit. Since no treated effluent has yet been discharged, it has not been necessary to have it tested by the state health office, and the present quality of the treated effluent is not known.

Colstrip has a permit to discharge into Armells Creek. As this will raise the level of the water in the creek for about half a mile downstream, adjacent area ranchers have agreed to a one-year test period to determine what side effects the discharge may have (City Manager, Colstrip, personal communication, July, 1975).

The sewer collection system is in good condition (City Manager, Colstrip, personal communication, July, 1975). The city manager feels that the pipes, which were all cleaned, checked and repaired two years ago, are adequate.

(2). Forsyth

Mountain West Research, Inc., reports that:[27]

Forsyth has a lagoon system with two cells totalling about 7.75 surface acres (Engineer, Morrison-Maierly, Billings, Montana, personal communication, August 6, 1975). Based on state design standards, 7.75 acres are sufficient for a population of slightly less than 800 people and an average of about 80,000 gallons of sewage per day. Montana-Dakota Utilities Company estimates the peak capacity of the lagoon to be 250,000 gpd, ("Community Analysis--Forsyth, Montana" Montana-Dakota Utilities Publication, March, 1975) although it could not handle this amount on a daily basis. There are no firm estimates of present usage;

figures range from 340,000 gpd (Montana-Dakota Utilities Publication, op. cit.) to 408,000 gpd (based on design estimates, 85 percent of the average water use being returned to the sewer system) for an average day; whichever estimates are used, the system is definitely over capacity.

The effluent discharged by the lagoons does not meet state health standards and can no longer be discharged into the river. The state has recommended that a third cell be constructed (City Clerk, Forsyth, Montana, personal communication, August 4, 1975).

The sewage collection system also needs repair. It was installed many years ago with short clay pipes which have subsequently settled irregularly resulting in several leaks throughout the system (City Clerk, Forsyth, Montana, personal communication, August 4, 1975). Forsyth has $150,000 budgeted for improvements to the sewer, and an engineering firm has been given a contract to do a complete study of the system. In the meantime the town is trying to purchase land adjacent to the present site for a third lagoon cell (City Clerk, Forsyth, Montana, personal communication, August 4, 1975).

d. Solid waste disposal

(1). Colstrip

Mountain West Research, Inc., reports that:[27]

Colstrip operates a state-qualified landfill for the use of the town's residents, the school, and the shopping area. The capacity of the site is virtually unlimited as they are old spoils pits at the adjacent surface mine. The garbage is dumped into the bottom of the pit, and then dirt is loosened from the sidewalls to cover the waste until the pit area is leveled out. The disposal site is then moved to a new pit.

(2). Forsyth

Mountain West Research, Inc., reports that:[27]

The solid waste disposal site for Forsyth also serves the adjacent rural area comprised of 12 townships for a total population of about 3,000.

The site is a state qualified landfill (County Sanitarian, Rosebud, personal communication, August, 1975). Approximately three acres have been filled and present use is estimated to be three pounds per capita, per day, or about 10,000 lbs. of trash a day. The site has been leased from a local rancher and the lease expires in June, 1976. It does not appear that the rancher will renew it, and a new site is being sought (Engineer, Morrison-Maierle, Bozeman, Montana, personal communication, August 6, 1975). If a site is found it is recommended that 16-18 acres be acquired; this should be sufficient for a 20-year period if present growth estimates are accurate (Engineer, Morrison-Maierle, Bozeman, Montana, personal communication, August 6, 1975).

The solid waste collection system, considered excellent for a small town, is operated by the city (County Sanitarian, Rosebud, personal communication, August, 1975).

e. Fire control

(1). Colstrip

Mountain West Research, Inc., reports that:[27]

The volunteer fire department, which provided for an insurance services rating of 7 three years ago, has 18 men. Their equipment consists of a 1938 Chevrolet pumper truck with a capacity of 500 gpm. This truck works well, but a new truck is needed. If assistance is required, the town may call on a 3/4-ton pickup with a tank and pumper from Burtco; another large truck with a tank and pumper from the power plant; and two water wagons, one with a 6,000 gallon tank and the other with an 8,000 gallon tank, from the surface mine. Water supplies and pressures throughout the town are adequate for fire protection.

At present the town is trying to get a new truck and some more small equipment; they are also attempting to organize a fire district that would probably include all the land within a five-mile radius of the town. In the fire district outside of the town limits, residents would subscribe on an individual basis for fire protection. With the money raised through taxes for the fire district, the town hopes to be able to pay for a new truck.

(2). Forsyth

Mountain West Research, Inc., reports that:[27]

Forsyth is served by a volunteer fire department with 16 men. The community has a class 7 rating (Fire Chief, Forsyth, personal communication, July, 1975). The department's equipment includes a 1952 International, 750 gpm pumper; a 1973 Ford Diesel, 1,000 gpm pumper; and on a stand-by basis, a 1946 American LaFrance, 750 gpm pumper; as well as standard small equipment (Fire Chief, Forsyth, personal communication, July, 1975).

At present, the town's water system has insufficient supply and inadequate storage to maintain a sustained flow and adequate pressures (Morrison-Maierly, Inc., Consulting Engineers, November, 1972). The state insurance services' office has recommended that the town be able to maintain a 2,500-3,500 gpm fire flow for a ten-hour period (Morrison-Maierly, Inc., *op. cit*.). The department has never had any problems controlling fires, and the Fire Chief feels that supplies are adequate. He would like to see the water improvements made, however, so that the town could regain its earlier class 6 rating (Fire Chief, Forsyth, personal communication, July, 1975).

f. Health facilities

(1). Colstrip

Mountain West Research, Inc., reports that:[27]

Medical facilities in Colstrip are at present limited. There are two first aid trailers, one located at the mine and one in town, each of which is staffed by a nurse. Residents of the town are served by the county hospital in Forsyth, but, due to the doctor shortage there, residents frequently go to other hospitals in the region particularly to those in Miles City and Billings.

There are two ambulances in town staffed by eight volunteer drivers, most of whom have had the Emergency Medical Training course. The doctor in Forsyth is paid a retainer fee and, in an emergency, patients are generally taken there. If the Forsyth doctor is busy, patients are taken to Billings or Miles City.

There are facilities in Colstrip for a dentist but the town has been unsuccessful to date in attracting one. A medical clinic is being built in the community center, and the Miles City clinic proposes to take charge of it. It is expected that a doctor will be hired to staff the Colstrip clinic (City Manager, Colstrip, personal communication, July, 1975).

(2). Forsyth

Mountain West Research, Inc., reports that:[27]

The Rosebud County Hospital, built in 1973, is a complete and modern medical facility serving Rosebud and Treasure Counties and an estimated population of 11,200 (as of 1975). A nursing home adjacent to the hospital was built in 1957 and is in fairly good condition. Last fiscal year, with 26 beds in the hospital and 39 beds in the nursing home, the hospital had 2,980 inpatient days and 2,283 out-patient days from June, 1974 to June, 1975. This year, eight beds were transferred to the nursing home, and the hospital is now certified for 18 beds and the nursing home for 47. The nursing home has 45 semi-permanent patients (Acting Hospital Director, Rosebud County Hospital, personal communication, July, 1975).

The hospital staff is comprised of two doctors and ten RNs, most of whom are part time; one of the two doctors is in semiretirement. There are three consultants, a pathologist, a radiologist, and a physical therapist, who come to Forsyth once a month; although, they are on call at all times. In addition to this staff there are two RNs and seven LPNs who work in both the hospital and nursing home, and two RNs who work only in the nursing home.

The doctor shortage at Forsyth has severely restricted the utility of the hospital, and many potential patients go to Billings, Miles City, or other regional hospitals. The town has tried to acquire a new doctor for five years but has so far been unsuccessful. It seems many doctors are either looking for a quiet town to retire in and do not want the Forsyth workload or are young and want the urban environment.

There is a clinic in Forsyth with one nurse. It is for sale, however, because the doctor who has it is retiring (Acting Hospital Director, _op. cit._).

There is one dentist practicing in town.

The Public Health Nurse in Forsyth serves the county's estimated 10,000 residents, and the major services provided are immunizations and screenings for school children. Home visits are provided by the service. The nurse has an active case load of approximately 100 people per month. Generally the office is staffed by one RN, although, occasionally there are student nurses or volunteers to assist with the work (Public Health Nurse, Forsyth, personal communication, September, 1975).

The mental health service in Miles City maintains an office in Forsyth staffed by a psychologist two days a week (Acting Hospital Administrator, Forsyth, _op. cit._)

Rosebud County maintains an ambulance service that has one full-time employee and, at present, three volunteer drivers from the sheriff's office. This number is low and they generally try to have six volunteer drivers available. All the drivers have had Emergency Medical Training (Ambulance Driver, Rosebud County, September, 1975).

There is one state qualified ambulance and a station wagon used for backup service. The ambulance is a 1971 model and fully equipped including a police radio. Another ambulance is needed, and plans for it are being finalized, and the service hopes to have it on order soon.

g. Law enforcement

Mountain West Research, Inc., reports that:[27]

Except for the Northern Cheyenne Reservation, the Rosebud County Sheriff's Department serves all the towns and rural areas of the county, an area of 5,037 square miles with a population of approximately 10,000 people. The department is staffed by the sheriff, an undersheriff, and 11 deputies. Men and equipment are stationed throughout the county with the sheriff, undersheriff, five deputies, and four patrol cars at Forsyth; three deputies and two patrol cars at Colstrip; two deputies and two patrol cars at Ashland; and one deputy and a patrol car at Birney (Sheriff, Rosebud County, personal communication, July, 1975).

There is one jail in the county which was built in 1904 and is located in Forsyth. Housed in the town hall, the jail is in poor condition and should be replaced as it does not have sufficient space, private attorney-client rooms, or adequate cooking facilities. The sheriff feels the department needs a new modern jail that will meet state requirements and tentative plans have been made for a facility that would accommodate 40 people: this will not only meet the present needs but also the county's projected population. The sheriff would like to see a second jail constructed at Colstrip, a community larger than Forsyth and one with a higher arrest rate. The sheriff has requested two more men, although ideally, he would like three or four more and another car. The department also needs an office in Ashland (Sheriff, Rosebud County, personal communication, July, 1975).

h. Schools

Mountain West Research, Inc., reports that:[27]

Rosebud County has nine elementary school districts and three high school districts. Two of the elementary districts and one high school district are in the northeast part of the county and outside the effective study area.

The rural schools are small but adequate for the needs of the students. The buildings are in fair to good condition, not overcrowded, and offer active school programs for their students (County Superintendent, Rosebud County, personal communication, August, 1975). The schools in Forsyth have excess capacities which could accommodate an additional 77 elementary students, 26 middle students, and 114 high school students. The grade school (capacity 326), built in 1920 is obsolete and should be replaced. The district plans to add to it a multipurpose room, two showers, a coed shop, a music room, and offices with a recently passed school district bond levy (School Superintendent, District 4, personal communication, July, 1975).

In Colstrip the schools are severely overcrowded. Present enrollments, 480 in the elementary grades and 200 in grades 7-12, far exceed the capacity of the present schools. The district has utilized vacant rooms throughout the town and brought in mobile units, for a total of 17 temporary classrooms, to handle the overflow. New school plant facilities are badly needed.

Montana Power Company has agreed to give the school district approximately ten acres adjacent to the present site for school expansion. Plans have been made for a new elementary school building, which will accommodate 350 students, and there are also plans to remodel the high school; the latter will then be able to handle 180-200 high school students. These planned capacities are based on the projected permanent population of the district; temporary units will be used to handle excess students during the intervening years (School Superintendent, District 19, personal communication, September, 1975).

i. Recreation facilities

(1). Colstrip

Mountain West Research, Inc., reports that:[27]

Recreation facilities are limited at present in Colstrip but an active construction program is underway. In a few years the town will have a complete recreation complex with a comprehensive park and pathway system, facilities, and programs. At this time there are two Babe Ruth League baseball fields, one other baseball field, two tot-lots, and one two-acre passive park with a fountain. The school gym is available for local use as well as a pond in an old mining area which, although officially off-limits, is used for swimming and canoeing. At present there is also a recreation center under construction that will have a gym, two handball courts, a weight-lifting room, meeting rooms, and a dancing area. The town has hired a recreation director who has scheduled a variety of programs (Recreation Director, Colstrip, personal communication, July, 1975).

Future recreation-related plans call for a total of 57 acres in parks and open space (Wirth Associates, Colstrip Parks and Open Space System, Billings, Montana). Planned facilities will include a swimming pool, bikeways, tot-lots, tennis courts, basketball courts, playgrounds, horseshoe pits, picnic areas, an amphitheatre, and a multi-purpose field (Recreation Director, Colstrip, personal communication, July, 1975).

(2). Forsyth

Mountain West Research, Inc., reports that:[27]

Recreational facilities in Forsyth include four city parks with a total of nine acres and offering a variety of activities, Babe Ruth and Little League baseball, girls' and women's softball teams, and a variety of special events held throughout the year (County Planner, Rosebud County, personal communication, July, 1975, and "Survey of Park and Recreation Facilities in Forsyth" prepared by Alan Rolston, LaDonna Cope, Bill Schwaynn, and Eldon Rice, June 11, 1975). In addition, there are two other parks not owned by the city.

Rosebud State Park, adjacent to town, has twenty acres with facilities for picnicking, camping and boating. The county fairgrounds are also located in Forsyth. Privately owned recreational facilities in town include a drive-in theatre and a bowling alley with a pool room. The Rosebud County Museum is located in Forsyth.

Future recreation plans for Forsyth call for additions to the picnicking and playground facilities and the provision of an all season swimming pool, a sand pit, and volleyball and basketball areas (County Planner, Rosebud County, personal communication, July, 1975, and "Survey of Park and Recreation Facilities in Forsyth, *op. cit.*).

j. Libraries

(1). Colstrip

Mountain West Research, Inc., reports that:[27]

Colstrip does not have a library, but it is visited twice a month by a bookmobile out of Miles City, the services of which are provided by the county. A local women's organization is establishing a library, and Western Energy Company has agreed to provide a two-story building with approximately 1,350 square feet (City Manager, Colstrip, personal communication).

(2). Forsyth

Mountain West Research, Inc., reports that:[27]

The library in Forsyth serves Rosebud County residents, and in addition, there are two bookmobiles from Miles City that serve Colstrip twice a month and the other county communities once a month (Librarian, Rosebud County Library, personal communication, July, 1975).

The library in Forsyth has 20,000 volumes and 35 periodicals. They also have inter-library loan agreements with the Federation and Processing Center in Miles City, the colleges in Billings, and the Pacific Bibliotec in Seattle, a program which makes almost any book available to local residents.

6. Archeological -- Historical

Early man utilized sandstone bluffs such as those found in Area B for concealment and shelter. They also provided: easy access to wood, an excellent view from high sandstone remnants, stone for building structures, and flat walls for engraving or painting (petroglyphs and pictographs). Also many of the sandstone outcrops at the summit contain porcelanite which was used to make tools.[4]

Prehistoric sites on these bluffs are varied and often include rock structures built for vision quests, eagle catching pits or odd structures for miscellaneous or unknown purposes including a number of rock shelters and lookout stations. While this type of topography is associated with bison jumps, no bison kills were located on Area B or other Western Energy lands, although several such sites are known in the vicinity.

The ponderosa pine areas which frequently adjoin the sandstone bluffs offered similar protection to prehistoric man. He could see without being seen, game was more plentiful and the area was easier to traverse. In the summer the trees offered protection from the hot sun. Almost all the archaeological sites located in the Western Energy surveys to date are within this zone.[4]

Evidence for prehistoric man's use of the Colstrip area grasslands is notably absent from the archaeological record. The lack of sites on the grasslands seems to indicate that prehistoric people avoided the grasslands as a living area for it is a zone in which man's physical or mental capabilities are of minimal advantage.

Prehistoric human habitation sites were not found along Armell's Creek, but instead were located in the sandstone and ponderosa pine areas near seeps and small springs. Only one prehistoric site was located next to a creek and not in the area of the proposed mine.[4]

Historically, the Colstrip area grasslands supported horse herds as these were the commercial stock on the early open range. Later homesteaders introduced cattle and while sheep were never extensively raised in the immediate Colstrip region, they were very important economically in the surrounding area.[4]

Large herds of cattle grazed the grasslands in the Colstrip area beginning in the late 1870's. Overgrazing, combined with the disastrous winter of 1886-7, forced an end to the era of the large cattle herds.

Homesteading began in earnest in the early 1880's. Evidence of such activity in the Colstrip vicinity is represented by a group of old homestead buildings located along Armell's Creek adjacent to Area B.[29]

The years between 1887 and 1930 were extraordinarily hard ones for the rancher. Herds were reduced from twenty or thirty thousand to two or three thousand. The cowboy became a fencer, a planter and a reaper of hay, a builder of sheds and corrals. Only the tough ones remained to adapt. The forage in existence at the end of the open range era was only a shadow of what it was at the beginning of the cattle business.[7] Today, the grasslands are used primarily for cattle grazing, but in some places such as those in Area B tracts have been plowed and planted to small grains.

Gold describes the history of the Forsyth-Colstrip vicinity as follows:[26]

In 1883, the Northern Pacific's line was completed through Forsyth and beyond; and Forsyth's first school was constructed at that time. The town thrived as a railroad division point, as the county seat, and as a shopping and commercial center, reaching its peak in 1923. In that year there were probably close to 2,500 people in town, including five or six medical doctors, an equal number of lawyers, and many bustling businessmen. The railroad strike of 1923, during which time about sixty families left Forsyth, led to a decline in the town's division point status and in its general fortunes. Mining at Colstrip helped Forsyth through World War II; following the shutdown of Colstrip's mine in 1959 there was a reduction in the number of railroaders at Forsyth, and the town's economy stagnated until revitalized by plant construction at Colstip in 1973.

The strip mine at Colstrip opened in 1923, owned by Northern Pacific and operated by its subsidiary, Northwestern Improvement Company, and was a big operation in the 1940's. Colstrip's school opened in 1924; Northwestern Improvement Company gave the school to the county (i.e., the local school district) in 1957, just two years prior to closing its mining operations. The mine was sold to the Montana Power Company on June 1, 1959, and reopened in 1968.

7. Transportation

Forsyth and Colstrip are connected by state route #315 which is narrow and inadequate to handle the present load.

8. Taxes

Table 18 illustrates the taxes paid by WECO together with coal tonages produced from the Rosebud Mine since 1968. These tax figures represent the combined gross amounts paid to the federal government, the State of Montana and to local government.

Table 18 --WECO tax payments 1968-1975.

Year	Total Production (tons)[a]	Total Tax Paid (dollars)
1968	150,000	5,020
1969	521,000	23,572
1970	1,658,000	95,220
1971	5,161,000	397,058
1972	5,501,000	847,781
1973	4,254,000	1,041,675
1974	3,212,000	1,353,989
1975	6,400,000	2,926,090[b]

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a. Production figures were obtained from the testimony of W. P. Schmechel, President of WECO, before the Montana Department of Natural Resources in January 1976. Tax figures were supplied by Michael R. Grende, Permit Supervisor for WECO, in a personal communication on March 30, 1976.

b. The tax figure for 1975 is a partial tax payment as the property tax and gross proceeds tax have yet to be assessed.

VI. ENVIRONMENTAL IMPACTS

A. Physical Environment

1. Air Quality

Increasing particulate concentrations in ambient air are believed to result in health problems to human populations. There are, of course, all degrees of exposure and the individual's susceptibility will vary. In areas outside of the town of Colstrip, the impact of particulates upon the ecosystem are hard to define. Particularly for coal dust, the lack of knowledge concerning environmental effects leaves numerous questions unanswered:

1. The deposition of black dust might cause increased temperatures on the surfaces of vegetation, soils and surface waters during periods of solar radiation - the black body (albedo) effect. Similarly, the long term deposition of dust might create more permanent thermal changes in the ecosystem the results of which are speculative (see section on vegetation impacts).

2. There are also unknowns with regard to the relationship between dust accumulations and the amount of trace elements on foliage. Would coal dust on forage result in detrimental accumulation of trace elements in grazing animals? Would long term accumulations result in eventual passage and accumulation of toxic elements in the local food chain?

The size of air borne particulates of both soil and coal may determine the potential environmental impact. Particulates of very small diameter in greater than normal concentrations may find their way into critical biological locations such that malfunctions result. For example, small particulates might enter plant stomata or the respiratory tracts of pollinating insects.

Little is known about the widespread effects of air borne particulate emmissions on indigenous ecosystems. Past studies on particulate problems do not offer the answers needed for this impact analysis. Future studies will supply more data but will probably never completely satisfy the array of ecological inquiries appropriate for this circumstance. One further inquiry consideration is the possible effect that coal mine emissions in the Colstrip area have on the monitoring of power plant emissions.

2. Geology

The amount of land surface to be disturbed in Area B includes 335 acres of pit, corresponding to the removal of 11 million tons of Rosebud coal. This area is also underlain by 4.7 million tons of McKay coal. In addition, Western Energy has also included the following acreages in this Area B permit application:

spoils and highwall reduction	156 acres
haul road	107 acres
associated disturbance	578 acres

The haul road and associated disturbance areas can be reclaimed so as to not appreciably alter the topographic contour of the original land surface. The 491 acres of reclaimed pit, spoils, and highwall reduction areas will, however, result in substantial changes in the surface topography. In addition, should WECo mine part or all of the McKay seam it may be expected that the spoils and highwall reduction area shall increase because of the additional spoil volume generated.

Area B is bordered on the south be erosional remnants which act as a drainage divide such that surface water flows to the north through Area B and to the south through the Peabody mine. Western Energy proposes to temporarily change the drainage pattern in Area B by constructing interception dams to divert the northward flowing drainage to the northwest around the mine area.

The stripping and replacement of overburden in mined out areas necessarily causes changes in its physical characteristics. Overburden commonly swells in volume by 20-30% during a mining operation as expressed by increased porosity. Possible effects include increased permeability - to both groundwater and surface runoff - and land subsidence as the regraded spoil gradually compacts.

3. Soils

In accordance with the Montana Strip and Underground Mine Reclamation Act, WECo removes topsoil and stockpiles it in a method to prevent loss and contamination.

It is the Department's practice to prescribe depths of salvage, based upon sampling and analysis data supplied by the company. The salvage depths as prescribed rely heavily upon the quality of sampling and analytical technique as well as the representative character of the sample size. A minimum of two profile samples are collected from each soil phase. These profiles are analyzed by genetic horizon to a depth of 84" or to bedrock. In topsoil salvage, the salvage of A, B, and C horizons is done collectively, resulting in a mixture of the three. It is common in Eastern Montana for the "A" horizon to be quite shallow, accompanied by a very thin or virtually nonexistant "B" horizon. The vast bulk of many salvage areas therefore is comprised mainly of "C" horizon material.

Considering that the "A" horizon is the primary soil area of organic material accumulation and biological activity, this zone is of primary importance as a vegetation growth media. Where such a horizon is six inches thick and the total salvage depth five feet, a dilution of the "A" horizon of about ten to one will occur. In the replacement of topsoil on spoil surfaces, those materials previously from the "A" horizon which end up at depths below the zone of aeration and biological activity are virtually lost to the process of revegetation.

Aside from the organic material and microbe populations, the upper layer and surface of the soil profile contain plant parts and seeds representative of the native community which was removed. The mixing and deep burial of these materials results in reducing the potential for vegetative regeneration and seedling emergence. Thus, the mixing of soil horizons results partially in the need for mechanical seeding for revegetation purposes, however. The mechanical seeding methods used therefore result in a greater use of introduced species in an effort to restore diversity. Such methods have thus far resulted in lesser plant diversity in reclamation areas than present before mining.

Separate salvaging and handling of the "A" horizon during periods of seasonal dormancy and the immediate reapplication of this material upon regraded areas with supplemental seeding would probably result in a higher quality and more rapid reclamation.

Overburden is also mixed to a considerable extent during mining but, as it is much thicker than topsoil, the extent of the mixing is probably more variable. Factors affecting the final homogeneity of a spoil pile include the undisturbed thickness of individual horizons, size of dragline bucket, number of lifts necessary to strip overburden, and amount of rehandle.

Breaking up and bringing a shale or sandstone horizon near the surface during the spoiling process obviously will cause it to begin weathering. This causes the release of nutrients and micronutrients which had previously been isolated below the areas affected by soil development processes. The rates at which such elements are released depends in large measure on how they are bound in the overburden material: in structural sites in clay minerals as opposed to being absorbed on surfaces or broken edges, in structural sites in other minerals, or as organic complexes. The use of chelating agents in the laboratory is valuable for determining the levels of immediately available nutrients, but does not provide information on how such levels may change in the long run.

4. Hydrology

(a) Surface water

(1) primary impacts

It is unlikely that the subject mining proposal for Area B will significantly affect the water quality or quantity of East Fork Armells Creek. Discharges of intercepted groundwaters as mine effluent are unlikely. In the event that such discharges did occur they would be similar in quality to present surface waters. No diversions of East Fork Armells Creek are proposed.

In their surface mining application, WECo proposes to "walk" its dragline across East Fork Armells Creek from Area A to Area B. This activity, proposed for May, 1976, will result in the destruction of some streamside and valley floor vegetation and temporary filling of the creek channel. Such activity will cause an unstable channel area in the disturbance zone. Erodible fill material will also be added to the creek area.

Coal dust has accumulated in several areas of the channel and has become part of the suspended load of the stream during flow. Its effects on water use are unknown.

(2) cumulative impacts

Continued mining in Area B, beyond that initially applied for, may lower the alluvial water table in Section 8, Township 1 North, Range 41 East, where several watering holes are used throughout the summer. It is difficult to assess this impact at this time since no long range mining plans have been submitted.

A stock reservoir (1N41E10BA) will eventually be consumed by mining activity.

(b) Groundwater

(1) primary impacts

Mining of the Rosebud Coal in Area B will interrupt some, but probably negligible, groundwater flow to alluvium along East Fork Armells Creek. Groundwater flow eastward to the existing mined area, and southeastward to Hay, Emile (Coalbank), and Miller Coulee will also be partially interrupted during mining. If at any time the active pit extends the entire length of Area B's southeastern edge, a length of almost four miles, intercepted natural flow will be less than 900 ft^3/day (.01 cfs). Influent rates to active pits will be greatest in the northeastern end of Area B where the Rosebud coal has an anamalously high transmissivity. Inflow there could initially be as great as about 2 cfs to a large pit but would decline rapidly because of the limited areal extent of the Rosebud coal and spoils. Under the assumptions that mine spoils will have similar hydraulic conductivities to undisturbed aquifers and that no mine cuts will remain open for permanent drainage, the post mining flow system should closely resemble the pre-mining one.[17]

Well 1N41E03CDDD will be destroyed by the mine operations. The well and its associated water rights are owned by Burlington Northern, and T & M Contract No. 3982 gives Western Energy Company the right to destroy the well in the process of mining. Well 1N41E08CBAB, will experience reduced yield since it taps the Rosebud Coal aquifer and is within two miles of the proposed mining area. Well 1N41E04DDBA may be impacted, however, its source of water is unknown.

It is unlikely that wells in 1N41E08 which tap alluvial aquifers, or the water table of East Fork Armells Creek itself, will be affected by Area B mining. The area is upgradient of the mining area, and the mining plan does not propose to disturb any alluvium. Thus, there should be no upstream "draining" of the alluvial aquifer. In the vicinity of Area B mining activity and downstream of it, there may be some slight decrease in bedrock recharge to the alluvial aquifer. This loss is expected to be insignificant, however, since there is relatively little water in the coal seam, the Rosebud coal outcrops above the valley floor, and any excess pit waters will eventually drain back into the valley system.

(2) cumulative impacts

The cumulative impact of concurrent mine operations, as presently proposed at Areas B, A, and E (Western Energy Company) and at the Big Sky mine (Peabody Coal Company) will be to establish localized "groundwater sinks" into each pit and to decrease groundwater flow in some sections. Hydraulic gradients may be steepened or reversed in some cases as flow is directed towards the pits. So long as no mine cuts intercept the alluvium of East Fork Armells Creek, the alluvial aquifer should remain essentially undisturbed.

A subirrigated meadow along Emile (Coalbank) Coulee (1N41E24) farmed by Jim Snyder, a local rancher, will probably be detrimentally impacted by the combined expansion of Area B and the Big Sky mine operations. Preliminary work by Van Voast indicates that this alluvial aquifer is recharged by bedrock aquifers which subcrop the valley fill.[17] Both mines will destroy these aquifers in the recharge areas and the system will not reestablish itself until mining at both areas is completed. Until that time, the water table will probably lower in Emile (Coalbank) Coulee. Likewise, the entire recharge area between Big Sky and Area B mines will be drained during the mining phase.

After the areas are reclaimed, pre-mining flow patterns should reestablish themselves. Quality of spoils groundwater will probably be as chemically variable as those found in the present spoils. Based only upon existing conditions in the other Western Energy mines it can be expected that post-mining waters in Area A through E will have dissolved-solids concentrations between 1000 and 5000 mg/l; that principal constituents of the waters will be magnesium and sulfate; and that some trace elements will be present in slightly but not alarmingly higher concentrations than in pre-mining waters. Continuing research in the Colstrip area is directed at determining whether post-mining waters will predominately more or less mineralized than other area waters and whether their chemical characterisitcs will be temporarily or permanently stable.[17] Most of the relationships involving spoil water chemistry are ill understood at this time.

B. Biological Environment

1. Vegetation

(a) vegetation destroyed

The most dramatic and critical impact on the vegetation in Area B would be its destruction by mining. On all areas from which the topsoil is stripped, the vegetation would be totally eliminated (this includes: the mining area, areas of highwall and spoil reduction, and haul roads). In the "associated disturbance" areas the effects on vegetation will vary from total destruction in some areas to relatively minor disturbances in others.

Most of the vegetative destruction in Area B can be mitigated; however, there are some which cannot be avoided under present mining and reclamation procedures. In these instances the environmental factors which created and/or maintained certain communities will be irreparably destroyed. Silver sagebrush (Artemisia cana) for example is a deep rooting species requiring a relatively high amount of moisture. There are indications that in many portions of eastern Montana silver sage tends to favor alluvial streambeds. These streambeds furnish a deep fertile soil with a plentiful supply of moisture and frequent recharge. In the proposed permit area silver sage is found primarily along drainages. The mining and subsequent reclamation for Area B will destroy these alluvial drainages, remove the deep alluvium, and hence eliminate a topoedaphic condition required for silver sage communities. Possibly in the future, after erosion and deposition have occurred on the reclaimed acreage, these communities may re-establish. In the forseeable future, however, communities or species relying on deep alluvium will be lost.

There is also some question as to whether the competitive advantage of deep rooting plants won't be lost for a period after mining. Eastern Montana is an area of boom and bust precipitation (Figures III and IV). Deep rooted species have an advantage in dry years as they can tap deep moisture stored in the soil. Mining destroys the soil structure and most likely the soil moisture regime as well. Until the moisture regime can be recharged and re-established there is little advantage to being a deep rooted species. A possibility exists that with the complete mixing and reversal of soil stratum this regime will never recharge thus spelling doom for many species during dry periods.

Certain species, particularly ponderosa pine and Rocky Mountain juniper require thin soils over broken rock. By rooting in the rock the plants obtain the necessary moisture. Other species may occur over hard pan areas and rely on moisture flowing over the hard pan for survival. Both these soil conditions would be destroyed by mining.

Vegetation diversity, a pattern which has developed over thousands of years, is also destroyed by strip mining. A recent study of "go-back" land (land which had been homesteaded and allowed to go back to native range) showed that after 60 years the communities on the go-back land were still significantly different from that on native communities.[30] This would indicate that it will take a long period of time (probably into hundreds of years) before the vegetation on reclaimed areas approximates the native, premining, vegetation. This is particularly true for forbs and small shrubs which are an integral part of the community and which will not be included in reseeding.

(b) decreased agricultural productivity

An immediate impact of mining Area B is removal of land from agricultural production - both small grain and livestock. Mining in Area B will result in the removal of approximately 400 animal unit months of grazing and the production of 6,300 bushels of wheat annually. (See Table 16 and Appendix G)[22, 31] While small grain production might possibly be resumed immediately after retopsoiling, livestock production should be prevented until the revegetated range has had an opportunity to reestablish.

(c) impacts of dust on vegetation

Soil and coal dust (air borne particulates) may influence the premining or reclaimed vegetation in the Colstrip area, (dust sources are discussed under air quality).

Dust impacts can be separated into three categories:

Dust on leaf surfaces will decrease the amount of light a plant receives thus decreasing its photosynthetic ability. This decrease would be particularly important during periods when the plant is under stress such as during seedling establishment, or during drought periods.

Dust on a leaf surface may interfere with digestion of the plant material by cattle. Dust of either type ingested and introduced to the rumen could adversely affect the digestibility of the plant material. There is also the possibility that dust could alter the pH of the rumen resulting in a change in the rumen flora.

Dust could change the microclimate surrounding the plant. Air borne dust might function as a screen, cutting down on the light received by this plant. Coal dust on or around the plant might have a black body effect raising the ambient soil and foliar surface temperatures. Both dusts also could negatively alter the topsoil in which the plant grows by introducing new chemical constituents. Particulate from overburden and coal may introduce trace elements to the soil and ultimately to the plant. Eventual toxicity could result, particularly from coal dust in which the levels of fluorides and metallic ions are high.

(d) cumulative impacts

If the Area B permit is granted, additional native vegetation in the Colstrip area will be destroyed, more natural diversity will be lost, and the tendency towards a vegetative monoculture will be increased. In addition, new acreage will have been removed from small grain and livestock production.

Considering the unstable market and the boom and bust climate under which local farmers and ranchers must operate, the loss of additional lands previously devoted for small grains or hay necessary for winter feeding could jeopardize the flexibility of their business. Dust from the mine expansion may also increase stresses on plants and animals. On leeward sites (where the wind velocity is decreased resulting in increased deposition), such stresses would be particularly acute.

By mining more acreage, ultimate reclamation success of the Colstrip area becomes more critical. Whether the Rosebud Mine can ever be reclaimed to its pre-mining state within the life of the present operation is subject to doubt. It is likely that the entire Colstrip environment is being modified due to micro-climatic changes. Such changes are caused by the loss of vegetation and changes in the topography as well as thermal and chemical changes resulting from the existing electrical generation plants. The size of the area influenced by the power plants is yet to be defined.

Increased human population in the Colstrip area also affects the vegetation, as horse, foot and vehicle traffic will undoubtedly increase on the adjacent rangelands. Off-road vehicles used improperly result in long term damage to vegetation.

2. Wildlife

(a) primary impacts

Acreage proposed for disturbance in Area B does not contain critical habitat for terrestrial wildlife except for small riparian areas to be disturbed when the dragline is walked across East Fork Armells Creek. Portions of the East Fork Armells Creek have already been disturbed by road construction and borrow area disturbances. With new activity along previously undisturbed portions of the creek, access to and from the creek bottom for terrestrial species will be substantially cut off.

The East Fork of Armells Creek has been described as critical habitat for whitetail deer and pronghorn antelope.[8] Information submitted by WECo does not substantiate this contention,[23, 24, 25] however, studies conducted after the commencement of road and mining related construction in the vicinity of of Areas A and B must be evaluated in light of the fact that there was little disturbance in this area before such construction began. Wildlife surveys of Area B, as it naturally existed, are now virtually impossible.

Other areas to be disturbed of importance to wildlife are the silver sage (Artemisia cana) and big sage (Artemisia tridentate) habitat types that cover approximately 40% of the permit area (Table 15). Sage is important to many species of wildlife, (i.e. sagegrouse, antelope, muledeer), during various seasons and weather cycles. In order to assure greater or equal productivity for such species, sage must be retained or reestablished.

Other shrub species of importance to wildlife in Area B are skunkbush sumac (Rhus trilobata), snowberry (Symphoricarpos spp.), prairie rose (Rosa arkansana), rubber rabbit brush (Chrysothamnus nauseosus), winterfat (Eurotio lanata), Rocky mountain juniper (Juniperus scopulorom), and broom snakeweed (Gutierrezia sarothrae)[25]. WECo has attempted to obtain seeds or seedlings for some of the above shrub species for use as reclaimed areas.

The proposed mining area contains sandstone bluffs and rock outcrops which represent important habitat to many non-game species. In the Colstrip area cliff swallows (Petrocheidon pyrrhonta), rock wrens (Salpinctes obsoletes), and white throated swifts (Aeronautes saratalis) have been observed around sandstone outcrops,[25] while several species of snakes and one species of lizard (Sceloporus graciosus) have recently been observed in both the bluff and rock outcrops.[32] Such areas are not being recreated on post-mining lands and are hence lost. No proposal for recreation of such habitats is presented in the permit application for Area B.

The ponderosa pine and ponderosa-pine juniper habitat types are found on scoria bluff and rock outcrop areas are also important to species. A small portion (.5%) of Area B is represented by these communities (Table 15). Higher areas on which these two habitat types occur are usually not mined due to unfavorable stripping ratios. Reclamation on ponderosa pine and juniper habitats will be very difficult unless a concerted effort is made to establish indigenous pine and juniper stock on topography similar to that which existed before mining.

The increased noise, travel, and other activities associated with Area B mining will undoubtedly exclude many species from the permit and adjacent areas. Loss of habitat by mining will exclude year around as well as transient users of the area.

(b) cumulative impacts

Cumulative impacts from WECo mining will occur on a wide area for the next several decades. The Area B mining permit, if granted, will increase by approximately sixty percent the total area presently bonded for surface coal mining and related disturbances in the immediate area of Colstrip (this excludes the area involving the nearby Peabody Big Sky Mine). In addition, WECo's "life of operation" (Figure I) indicates that thousands more acres are scheduled for future mining disturbance.

Additional mining, followed by reclamation, is but one of the long-range impacts that Colstrip wildlife faces. Because of the energy that this locale produces in the forms of coal and electricity, the community of Colstrip is an industrial "boom town." Cumulative impacts upon wildlife thus become an additive and interrelated sum:

1. Noise levels grow as new electro-generation plants begin operation, blasting frequencies increase, traffic flows and recreational vehicles increase.
2. Food and cover is lost not only to strip mine operations but also to homes, roads, and powerlines.
3. Pollutants in the forms of high soil trace element lands and fugitive dust from mining, etc., are added to the pollutants (NO_X SO_X and HF, etc.) submitted by the electrogeneration units.
4. Legal and illegal hunting pressures grow. Two recent memos from game wardens living in Forsyth and Hysham indicate that hunting pressure on the ranches surrounding Colstrip has grown substantially since 1973 (Appendix H). The influx of a large number of people has led to increased trespass and poaching problems which in turn have created bad feelings among local ranchers. The result has been the closing of many Colstrip area ranches to public hunting. Other problems include residency violations in the purchase of hunting licenses. Lastly, the memos point out that high company officials, as well as the transient Colstrip workers, have been caught violating State game laws.

C. Human Environment

It is difficult, if not impossible, to fully evaluate the potential social and economic impacts of a mine expansion within the context of the existing environment of Rosebud County. Coal mining has already significantly stressed the social structure and social services of this area and resultant changes in the human environment are already occurring. As shown in the section entitled "description of the environment," mine expansion will contribute to the urbanization of a traditionally rural area. Extension of the Rosebud Mine at this time will create jobs and help maintain the business boom, but it will also stress the already overused public facilities in Forsyth and Colstrip.

1. Population, Employment, Housing and Local Economy

The proposed mine will add to the long-term population of Rosebud County. WECo has indicated that Long Construction, the mining contractor, for their Rosebud operation will hire 60 to 80 new employees prior to June 1, 1976, provided the application for Area B is approved.[2] The expansion of the Rosebud Mine will provide jobs for locals who wish to seek employment outside of the agricultural sector, for other Montanans, and for out-of-state residents attracted to the area in anticipation of a job. In addition, an unspecified number of "derivative jobs" will be created as a result of adding 70 to 80 more employees to local (Rosebud County) payrolls.

Derivative jobs include railroad employees, barbers, clerks, gas station attendants, etc. WECo has indicated that because of the growth of the Rosebud mining operation, other private businesses are already becoming interested in establishing at Colstrip.[2]

The impact of 70 to 80 new miners could be negligible if no further power plants are constructed at Colstrip and the population as a result stabilizes or is even reduced when construction of plants #1 and #2 are complete.

Until more housing is constructed at Colstrip, most new employees will have to reside in other areas. WECo has indicated that 57 current employees of Long Construction wish to live in Colstrip, but are unable to find housing.[2] Some additional housing will become available in Colstrip as construction projects are completed on their #2 electrical generating unit.

The immediate population and housing impacts of WECo's mine expansion will fall on Forsyth much more than Colstrip. It is important to note that Forsyth is a crew change point for the Burlington Northern coal trains and railroad employment in Rosebud County increases by about approximately 30 workers for every ten million tons of coal leaving the mines.[27] At a projected production rate of 5,500,000 tons, Burlington Northern will probably have to hire an additional 16 employees who live in Forsyth in order to accommodate Area B shipment.

2. Historical - Archaeological

The historical and archaeological survey submitted as part of WECo's Area B Surface Mining Permit application showed that there are no sites of enduring interest within the proposed permit area.[4]

3. Transportation

State route #315 has generated much local demand for improvement.[28] This local highway previously served as a farm-to-market road and now largely as a result of the coal boom carries a traffic volume of about 830 cars per day.[27] Although sufficient data is not available to determine exact changes in vehicle composition, roads serving coal development sites not only have an increase in the volume of traffic but also an increase in the number of trucks and heavy vehicles. This has led to a deterioration of road surfaces.

Unless route #315 is repaired, approval of this mine expansion will likely result in accelerated deterioration since more workers will be employed at Colstrip.

4. Taxes

Taxes generated by the proposed Area B operation would generate considerable revenues to both the state and to Rosebud County. Table 19 gives the estimated taxes resulting from the Area B operation. Estimates are based on the assumption that the 1976 Area B permit and future permit applications are approved. Not included in the table are corporation license taxes, employment security taxes or property taxes.

Table 19 --Estimated taxes for WECo's Area B 1976-1985[a]

YEAR	PRODUCTION (TONS)	SEVERANCE[b]	GROSS PROCEEDS[c]	RESOURCE INDEMNITY TRUST TAX[d]	TOTAL[e]
		TAXES (DOLLARS)			
1976	1,330,000	$1,396,000	$230,000	$35,000	$1,661,000
1977	4,750,000	3,979,000	659,000	75,000	4,713,000
1978	5,500,000	4,495,000	744,000	85,000	5,324,000
1979	5,500,000	4,495,000	744,000	85,000	5,324,000
1980	5,500,000	4,495,000	744,000	87,000	5,326,000
1981	5,500,000	4,495,000	744,000	88,000	5,327,000
1982	5,500,000	4,495,000	744,000	89,000	5,328,000
1983	5,500,000	4,495,000	744,000	90,000	5,329,000
1984	5,500,000	4,495,000	744,000	92,000	5,331,000
1985	5,500,000	4,495,000	744,000	93,000	5,332,000

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a. Source: letter from Mike Grende, Permit Supervisor WECo, to Charles van Hook, Department of State Lands, February 18, 1976.

b. The new coal severance tax provides revenues for the state general fund, the impacted county's general fund, and to eight other funds.

c. Basically a property tax to the county.

d. To the state.

e. This total, as noted above, does not include the property tax. As a rule of thumb, 98% of all property taxes go to local governments.

5. Human Health

Montana coal mines have not had a fatal accident in at least four years.[33] The national fatal frequency for coal strip mines is 0.41. The non-fatal lost time accidents frequency rate is 30.96 nationally and 13.50 for the Rosebud Mine.[33]

$$\text{Frequency Rate} = \frac{\text{no. lost time accidents} \times 1{,}000{,}000}{\text{no. man-hours worked for the year}}$$

This rate should be maintained or improved if the safety training programs at the Rosebud Mine are continued. An employee's first two weeks on the job are the most hazardous so orientation training is important to both new employees as well as old employees changing positions.

Blasting associated with mining could potentially damage buildings, wells, streets and other structures in the Colstrip vicinity. The town of Colstrip is already bordered by mining in Area A to the west, Area E to the southeast, and power plants northeast of town. The proposed Area B mine would increase the amount of, and blasting disturbance to the southwest of Colstrip. Western Energy, however, has taken measures to keep the vibration level below two inches/second.[2] At this level, structural damage is not expected to occur.

There is no data readily available that would indicate if blasting vibrations has adverse affects on the human population.

D. Other Impacts

In the collection of data for the Area B EIS the Department requested from WECo information concerning the environmental impacts of surface subsidence, and waste disposal at the Rosebud Mine. The following is a report of two Departmental inquiries[34] and WECo responses.[2]

I. Surface subsidence

a. Departmental question

The Department understands that a swelling or volume increase is associated with the removal and replacement of overburden. It is also understood that a surface subsidence phenomena has been observed at surface mining operations in other parts of the country. Does the company have any knowledge of this activity which could allow predictions of it's effect upon the engineering of surface drainage or impoundment construction in mined areas? Also, are there any monitoring programs proposed or possible which would allow observation and evaluation of this phenomena?

b. WECo response

Several individuals contacted for information on this topic expressed reservations about use of the term "subsidence;" it has therefore been arbitrarily defined for use in this report as synonymous with "compaction," i.e., "decrease in volume of sediments, as a result of compressive stress, usually resulting from continued deposition above them, but also from drying and other causes" (Dictionary of Geological Terms, 1974).

There appear to be no published data or documented information on surface subsidence related to backfill of western strip mines. None of the individuals listed below could provide specific data on backfill compaction, or knew of any on-going studies. Don Donner (personal communication) of the U.S. Bureau of Mines, Mining Research Division, hopes to establish studies on this subject in the near future.

A certain amount of compaction must be expected in every case of backfill (Dulles White, personal communication). Gravels exhibit very little subsidence, while silts may continually settle for many years (Miller Hanson, personal communication). Western Energy Company's Colstrip mine is located on rather sandy soils; Fred Sandoval (personal communication) of the Northern Great Plains Research Center does not expect much subsidence at this particular site. Thomas Finch of the Montana College of Mineral Science and Technology Foundation (personal communication) reported to Mike Grende that "the Foundation Engineering Handbook published by Van Nostrand Reinhold Company, 1976, points out that sandy materials basically have the same cohesive properties in the dry state and in the wet state. Therefore, because Western Energy's overburden consists of a predominantly sandy material we would not expect an excessive degree of compaction beyond the first year of reclamation." Miller Hanson (personal communication) cautioned that clays associated with coal seams, when mixed with other spoils, could affect degree of compaction.

Compaction will be affected by the physical nature of the backfill, moisture, freezing-thawing, whether or not debris (junk) is placed in the backfill (Fred Sandoval, personal communication), and the degree of mechanical compaction during backfill (Jim Link, personal communication). Spoils at the Western Energy mine swell approximately 25 percent (Tim Wood, personal communication); however, "reclamation regrading after mining would provide a large degree of compaction in itself. It has been estimated by Tom Finch of the Montana Bureau of Mines that upon replacement of the overburden up to 80% of the settling would immediately take place." (Mike Grende, correspondence).

At present, Western Energy Company does not plan to monitor compaction at the Rosebud Mine (Tim Wood, personal communication). Monitoring/prediction experiments might be similar to those used by the U.S. Army Corps of Engineers to determine amount of settling in earthfilled dams. A grid of known elevations could be established across the backfill, then monitored for 1½-2 years. Compaction would be logorithmically interpolated from these values (Carter Johnson, personal communication). Jim Link (personal communication) suggested that from grid elevations correlated with rainfall data, compaction could be determined by a computerized mathematical model.

Alternatively, a lab experiment could duplicate the amount of short-term compaction of backfill materials; consolidation could then be tested under loads equal to that expected at various depths (Carter Johnson, personal communication).

Settling of spoils piles at Colstrip may also be considered in this discussion. In a January 29, 1976, conversation with a Consolidation Coal Company employee (Dennis Garnett's office), it was reported that Mr. Sherm Lange (now deceased), who had been employed by the Northern Pacific Railroad at the Colstrip mine, stated that a spoils pile which had a higher percentage of clay materials than other overburden encountered had settled approximately six inches in 15 years. A water tank was allegedly erected on this pile.

New spoils ridges piled against older ridges (that have already settled) may present a problem. In Area E of the Western Energy Company mine, two new ridges were placed against a ridge erected approximately 25 years ago by the Northern Pacific's operations. The new spoils were deposited during winter, when frost depth was approximately 14-15 inches. In the spring, the new ridge moved downhill along the old ridge face, moving approximately 20 feet laterally and 10 feet vertically (Mike Grende, personal communication). This situation is not a common one, and as mining progresses away from the old spoils it should not reoccur.

In summary, little is known about surface subsidence of western strip mine backfills; from available information, compaction is not expected to be a serious problem at Western Energy's Colstrip mine. More accurate predictions of compaction would likely be predicated on long-term monitoring of environmental conditions; but Western Energy Company does not plan to monitor compaction at its Colstrip mine because it has not presented any problems.

Individuals contacted for subsidence information:

Donner, Don: U.S. Bureau of Mines, Denver, Colo.; February 2, 1976

Garnet, Dennis; Consolidation Coal Co., Billings, Montana; January 29, 1976.

Grende, Mike; Western Energy Co., Butte, Montana; correspondence January 29, 1976; personal communication, February 6, 1976.

Grimm, Elmore; Environmental Protection Agency, Cincinnati, Ohio; February 2, 1976.

Johnson, Carter; U.S. Army Corps of Engineers, Omaha, Nebraska; February 2, 1976.

Link, Jim; U.S. Bureau of Mines, Mining Research Div., Denver Colorado; February 10, 1976.

Nickels, Harry; U.S. Bureau of Mines, Denver, Colorado; February 2, 1976.

Sandoval, Fred; Northern Great Plains Research Center, Manclan, North Dakota; January 29, 1976.

Schearer, Leonard; Peabody Coal Co., Denver, Colorado; January 29, 1976.

White, Dulles; U.S. Bureau of Mines, Denver, Colorado; January 29, 1976.

Wood, Tim; Western Energy Co., Colstrip, Montana; January 29, 1976.

2. Waste disposal

a. Departmental question

There is a need to thoroughly examine the nature of the waste generated in the operation and maintenance of WECO's mining activity. Such materials as fuels, lubricants, solvents, paints, explosives, coolants, etc., need to be clearly identified, in a chemical sense, in order to prescribe proper management. The volumes of waste material, be it solid or liquid are also needed to determine proper disposal methods. Of most concern in land management is the location of disposal sites and how they will influence future land use prerogatives. The company has designated areas permitted by the state for waste disposal. However, other facilities such as sumps or septic tanks related to shop or maintenance facilities are unknown. Please indicate the nature, volume, and disposal location of your waste materials.

b. WECo Response

A review of refuse disposal for the shop, warehouse and crew building areas indicates that approximately 40 cubic feet of firmly packed trash is disposed each day. This trash consists of the following major items:

Sweeping - dirt from haul units, etc.

Packing crates - wood

Pasteboard boxes

Oily rags

Oil filters

Steel cuttings - lathe and drill press

Scrap iron - broken small parts

Radiator hoses

Tires - Pickup sizes

Plastic

Welding slag

Crew shack garbage

This material is disposed of in approved locations.

The monthly consumption of major petroleum products is approximately:

Oil	1900 gallons
Anti-freeze	300 gallons
Solvent	1200 gallons

Some of the oil used is changed in the field instead of the shop area. This work is normally done along the pit highwall where the oil is disposed of on the ground. During overburden stripping for the next cut, this waste is widely distributed throughout the spoils.

It is the current policy of Western Energy Company that the remainder of the waste oil, anti-freeze and solvent is disposed of in areas approved by the Department of State Lands and shown on permit exhibits. Western Energy Company realizes that a more desirable solution for petroleum waste disposal is to recycle the waste. The company is attempting to locate a recycling firm that will take the petroleum waste products.

VII. MITIGATION OF IMPACTS

A. Physical Environment

1. Air quality

WECo. is engaged in two primary efforts to reduce particulate emissions from mine related activities:

a. Water trucks are used to reduce dust emissions from haul road surfaces. To date the Department feels that the watering of haul roads has not been frequent enough to adequately suppress dust.

b. The company is engaged in an active program to revegetate mining disturbances. Revegetation of mining disturbances is subject to numerous climatic and operational variables which result in the exposure of vast areas to wind erosion.

The following suggestions are made to further mitigate fugitive dust problems at WECo.'s operation:

a. Cover or enclose areas of coal handling activities to reduce loss of coal dust. The use of a polymer based spray might also be explored.

b. Increase watering of haul roads and other surfaces where vehicular traffic causes dust emissions.

c. Organize the planning of overburden movement to take advantage of seasonal precipitation peaks.

d. Develop methods of equipment operation which will reduce dust emissions. Such improvements may also result in reduced health and safety hazards as well as reduced maintenance costs.

2. Geology

As mining progresses, spoil piles will be reclaimed in accordance with the Montana Strip and Underground Mine Reclamation Act. Spoil piles will be regraded to a maximum of 5:1

slopes, retopsoiled and reseeded. This procedure will mitigate the possibility of mass wasting or soil erosion. The final northwest trending pit will receive drainage from the southerly drainage divide and carry it to another stream channel northwest of the mine site. This will reduce the volume of surface water entering the regraded spoils.

3. Hydrology

Any discharges from mining areas must meet the standards of the Rules and Regulations adopted pursuant to The Montana Strip and Underground Mine Reclamation Act and the water quality standards of the State. Settling ponds will be established where any pit waters leave the permitted area.

Disturbances in East Fork Armells Creek could be avoided if a buffer zone were established between the stream and the mine operations. Western Energy Company has proposed a 100-foot buffer zone. Protection of valley resources could best be achieved if all disturbances were prohibited on ground underlain by East Fork Armells Creek alluvium.

Western Energy Company has not formally presented a program design for the crossing of East Fork Armells Creek with the dragline. Crossing at a time of no streamflow and the placing of a protective cover under the dragline route would best protect the area. Any fills left in place, or bare ground left exposed, would lead to excess sedimentation in the creek.

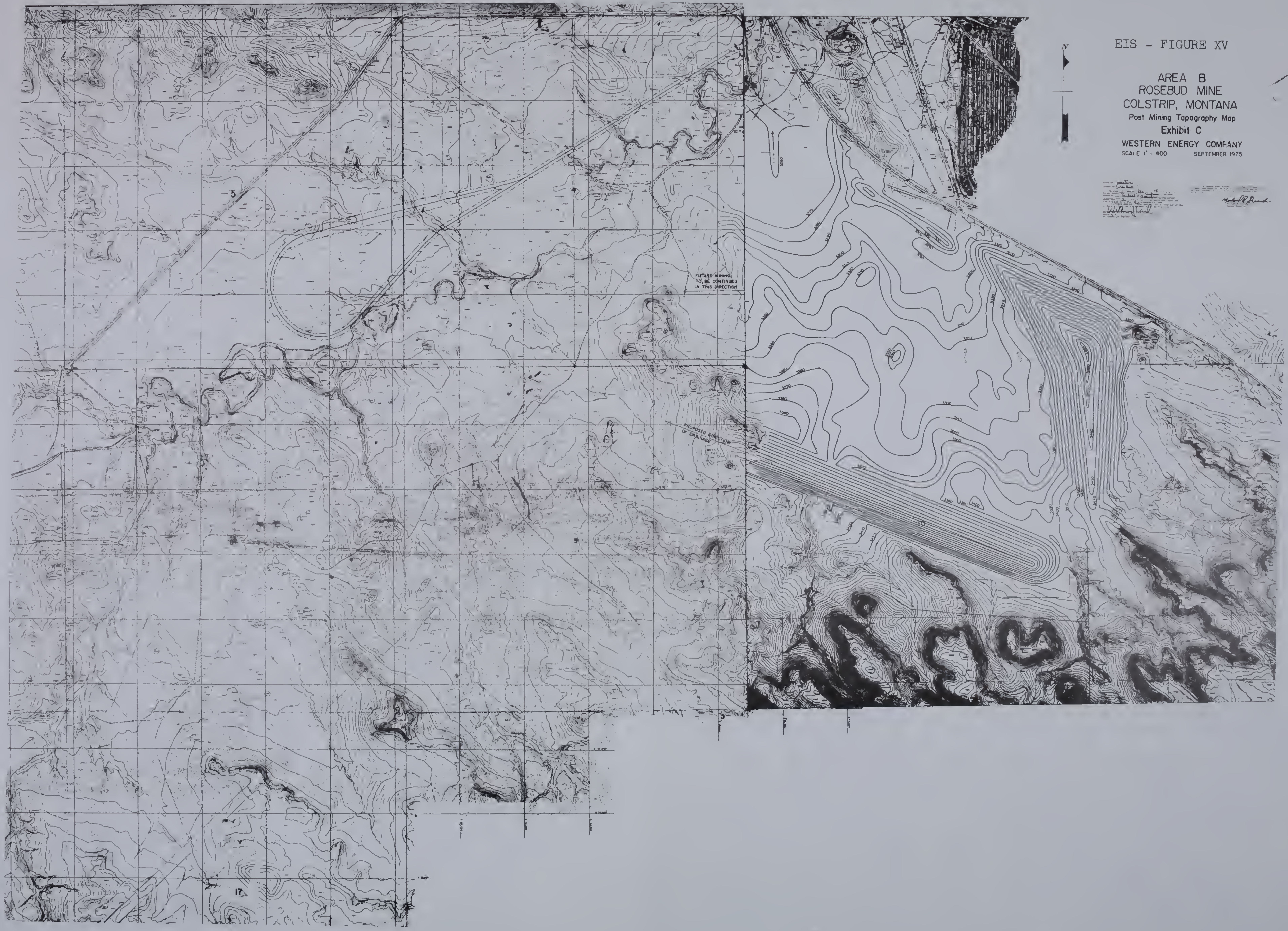
Covering of the coal storage area in Area A would minimize accumulation of coal dust in stream channels.

Western Energy Company has requested Department of State Lands' review of a regrading plan whereby a shallow impoundment would be left near the creek channel, in the location of the initial mining cuts. To date, insufficient information has been provided the Department regarding the plan and the Department has rejected this alternative. If Western Energy Company resubmits the regrading proposal at a later time with more detailed data and engineering design, it will be reconsidered. Figure 15 shows the proposed recontoured surface for Area B without the proposed shallow impoundment.

4. Soils

One problem is the considerable variation in suitable topsoil thickness as shown by the recovery depths printed on the soil map (Figure 10). These depths were set so as to exclude any soil material not conducive to plant growth, either on the basis of high conductivity or clay content. Because of variation within soil units, on-site evaluations will have to be made and stripping depths subsequently staked. If it should appear that insufficient topsoil can be obtained in Area B, the Department may request that topsoil be brought in from Area A stockpiles.

Analyses of four of the overburden test holes indicate high conductivity in the upper 10'. Because these are composite samples, it is not certain whether the salt hazard is in the topsoil or overburden. Further testing will be needed however.


N
5
17
FUTURE MINING TO BE CONTINUED IN THIS DIRECTION
PROPOSED DIRECTION OF DRAINAGE

EIS - FIGURE XV

AREA B
ROSEBUD MINE
COLSTRIP, MONTANA

Post Mining Tapagraphy Map

Exhibit C

WESTERN ENERGY COMFANY

SCALE 1" = 400 SEPTEMBER 1975

If the problem is indeed in the overburden, the Department will require that, after the topsoil is removed, overburden to a depth of 10' below the original land surface be buried.

The upper 30' of core hole N 45E55 contains excessive amounts of zinc, an element which has definite toxic effects when present in high amount, particularly in the suppression of iron uptake by plants. Again, the analyses were run on 10' composite samples; a procedure which makes it impossible to establish whether the topsoil over the hole is affected along with the overburden. Furthermore, the geologic logs available are those included in the overburden analyses. These logs are descriptions of the same 10' composites. (see appendix C) Such a coarse scale of geologic data makes it impossible to attempt correlating zinc content with lithology. The Department will require special handling of the high zinc material in the event that it is not to be buried during the natural course of the mining operation. Additional analyses will be necessary in order to establish the lateral extent of the high zinc areas.

Core hole N 45E57, also, has high zinc levels at the 20-30' level. If this sample is not from an extensive area of high zinc concentration then a thorough mixing of overburden should prevent any difficulty. Such mixing would also disperse the clay layers at the 10-30' level.

B. Bioloigcal Environment

1. Vegetation

Area B will be reclaimed subject to the provisions of the Montana Strip and Underground Mine Reclamation Act. Long range productivity of the area is dependent upon successful reclamation. According to the Reclamation Act, the permanent, diverse vegetation cover that is required must be capable of regenerating under natural conditions and be able to withstand grazing pressure comparable to that prior to strip mining.

The species planted on the retopsoiled areas must be ". . . of predominantly native species" (M.A.C. 26-2.10(18)-S). Some of the native species in Area B, however, are not desirable for revegetation purposes. Many species which occur on the area as a result of overgrazing should not be replanted for livestock production. In reclaiming mining disturbances, care must be taken so that species required by wildlife for food and/or cover are not eliminated. For example, sagebrush, although not desired on livestock ranges is vital for the survival of certain species of wildlife. Care must therefore be taken in determining species to be used in revegetation. Consideration must also be given to all species of animals using the area.

A basic question to be considered with regards to mitigation is, will reclamation/revegetation ultimately succeed? No reclamation in the Colstrip area has been determined sufficient for bond release by the Department under criteria established by law; such a determination will indicate successful reclamation as determined by the Department. As shown in Figure IV, the rainfall in the Colstrip area since reclamation efforts began has been average or above. The effects of a dry period such as that from 1947 through 1952 on reclamation have not been observed.

Four successive years of below average precipitation results in a depletion of the soil moisture in the upper strata. At this point deep roots become critical. If the plants have not yet developed deep roots, or the realignment of the soil substrata has eliminated the advantage of deep roots, the plants will perish. If, as in 1947-52, the very dry years are followed by a year of above normal precipitation and another year of below normal precipitation, recharge would be limited. In undisturbed native communities such a precipitation pattern would simply shift community composition. Annuals, bienneal and shallow rooted perennial grasses and forks would be reduced, while deep rooted perennials would persist on deep moisture.

Most native plants dropping out under such drought conditions have a long seed life allowing them to reestablish under more favorable conditions. Recently reseeded plants do not yet have deep roots nor do they have a long seed life. It is not known how long reseeded plants would have to be established prior to such a drought in order to survive.

Under reclaimed conditions a drought stress is magnified because the plants have been seeded on a barren, disturbed site. Even if revegetated species can establish deep roots they may not benefit as a result of the disrupted soil moisture regime. Some exotics might fare better than the natives and, as a result could become dominant.

Another potential problem which may be encountered in present reclamation efforts is that of fertilization. Fertilization is designed to alleviate plant nutrient deficiencies in the soil. The problem is, that the reestablished vegetation may be an artifact of the abnormally high nutrient levels. Sindelar et. al. states "what is not known is the degree of dependence of vegetation established on mine spoils on continued fertilization."[21]

Future reclamation should attempt to mitigate environmental conditions which presently appear irreparably destroyed. Rock areas could conceivably be reconstructed by salvaging rock material and replacing it after mining. The replacement of alluvial or hardpan areas offers a far greater challenge.

Other impacts may only be mitigated by long periods of time. For example, the re-establishment of trees and shrubs from seedlings, and a return to natural diversity will both require periods of time to allow succession.

For example, a return to natural diversity, as evidenced by the re-establishment of native trees and shrubs from seed, will occur only after several stages of vegetative succession. Such succession takes many years to occur.

Revegetation experiments have been in progress at WECo's Rosebud mine since 1968. These studies have been directed by personnel of the Montana Agricultural Experiment Station, Bozeman, in cooperation with the WECo and several other organizations. Detailed descriptions of each experiment are available in a series of published technical reports and papers.[35,36,37,38,39,40]

A skeletal summary of these reports was prepared for the Department by WECo. This summary, divided into three categories: soils experiments, species trials, and fertilization tests, is available for public review in the Department's Helena offices.[2] The Department encourages research on reclaimed spoils, however, no bond on such areas will be released until they satisfactorily meet the reclamation criteria found in the Montana Strip and Underground Reclamation Act and the rules and regulations adopted pursuant to it. To date no bond has been released for successful reclamation, in terms of revegetation establishment.

2. Wildlife

Only by carefully addressing the needs of wildlife prior to the reclamation effort will reclamation satisfy the food, water and cover needs of the species native to the Colstrip area.

WECo has made a small effort in this direction in that several native shrubs important to wildlife, will be planted on their Pit 6 and Pit 6 extension areas. Present reclamation plans are not primarily directed to wildlife needs, however. Instead the aim appears to be to increase productivity for beef cattle and for monotypic grain crops.

Section 50-1045(a) of the Montana Strip and Underground Reclamation Act requires that reclaimed lands " . . . be capable of feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation." Due to the maximum 5:1 grading requirements of the Act, however, reclaimed lands may be made more suitable for crop or range uses than existed in the pre-mining condition. Creation of monotypic cropland benefits few species of wildlife and in fact represents a potential long-term negative impact for many. The problem of reclaiming strip mined lands for wildlife is compounded by the fact that substantial unknowns exist in the habitat requirements for many species.

In light of the pressures which will affect Colstrip wildlife, the need for an intensive effort to recreate lost habitat is clear. One idea which has merit is the establishment of game management areas on reclaimed or other acreages. Such areas would be managed primarily to enhance the productivity of the native fauna. Were successful reclamation to occur over all mined areas, and were such areas interspersed with game management sections, the quality of wildlife habitat might equal or surpass that which is currently in existence.

C. Human Environment

1. Housing

After mid-1976 WECo anticipates that Colstrip's population will undergo a slow and steady growth rate of 1-1¼% per annum.[2] (This estimate may change based upon that final decision of the pending application to construct electric generation units 3 and 4.) If the growth rate does indeed prove to be slow and steady, home construction and trailor court development may eventually satiate the current demand for housing.

WECo has indicated that they wish to turn future development of Colstrip over to private individuals:[2]

> " . . . Montana Power and Western Energy believe the companies responsibilities to the townsite have been fulfilled . . . . The company therefore wants to remove itself from the landlord-tenant relationship to the townsite and its residents. The desire is motivated by the realization that the company/town relationship is not necessarily a desirable one. That relationship is not always good for the company, nor for the town residents . . . .
>
> . . . Montana Power wants to get out of competition with other private enterprise firms; firms that in some instances are the customers of Montana Power. It is felt that private home builders and private commercial firms can do a better job of completing the development of the townsite because it is day-in and day-out business routine of these companies."

2. Social Structure

Social impacts cannot be satisfactorally mitigated by preplanning. Instead, the processes of attitudinal changes, and acceptance of a new "status quo" occur slowly. To some degree the socioeconomic differences between mine employees and ranchers or company officials and local anti-mining forces may never be resolved.

One positive impact of the proposed mine expansion is that the 70-80 new workers will tend to be long-term employees. Miners, in comparison with construction "boomers" tend to stay longer in a community as evidenced by the fact that they more often bring their families.[26]

3. Social Services

Through community planning, Colstrip and Forsyth residents may be able to satisfy the growing demand for social services. State and federal grants are available for such purposes through a variety of assistance programs.

The Montana Coal Severance Tax is presently generating revenues at the Rosebud and other southeastern Montana coal mines. Portions of such monies will be made available to Rosebud County in the following ways: coal area highway development, Local Impact and Education Trust Account, school equalization support, direct payments to the county's general fund, land use planning funds, and park acquisition.[41]

4. Transportation

Highway #315 has been proposed as a first priority for coal impact funds, with the work slated for completion by 1980.[27] The State Highway Department has assumed responsibility for upgrading the road and estimates that the cost of rebuilding and resurfacing the road from Forsyth to Colstrip range from $60,000 to $80,000 per mile.[28]

VIII. Irreversible and Irretrievable Commitments of Environmental Resources

Assuming that all of Area B will eventually be mined and a 95% recovery rate, approximately 158 million tons of coal be produced. Coal is an irretrievable energy source.

One well will be destroyed in the process of mining and two others may be affected. A stock reservoir will eventually be consumed by mining activity.

If reclamation is not successful the surface utility as livestock range, for growing grains and for wildlife will have been sacrificed for the recovery of the minerals.

The energy needed for the production of coal at Colstrip includes diesel fuel for the crawler and rubber-tired equipment and electricity for the draglines, shovels, large drilling equipment and coal handling equipment. The energy needed to produce one ton of coal was found to be:[2]

Diesel fuel - 0.285 gal./ton of coal = 40,000 BTU
Electricity - 4.7 KWH/ton of coal = 16,000 BTU
56,000 BTU

Because Western Energy Company ships coal to several different consumers, transportation energy costs were averaged. For the purpose of this analysis, it was assumed that an average weighted round trip was approximately 1,500 miles.

It was estimated that 600-800 BTU were required to transport one ton eof coal one mile.

Transportation energy costs would then be 900,000 - 1,200,000 BTU/ton of coal.

The total of the main energy costs for coal production and transportation is approximately 956,000 - 1,256,000 BTU per ton of coal.

Assuming Colstrip coal averages 8600 BTU/lb., each ton of coal has approximately 17,200,000 BTU.

Then:

Energy consumed as percent of energy produced (using higher figure) $= \frac{1,256,000}{17,200,000} \times 100 = 7.3\%$

IX. COMPARISON BETWEEN SHORT TERM COSTS AND LONG TERM PRODUCTIVITY

The most obvious conflict is between the traditional use of the land for growing grains and as rangeland and the proposed short term use for surface mining. WECo wants to permit 1,176 acres for mine expansion, an area which will most likely be fenced for the duration of mining.

If reclamation is successful, the long term use of the land for agricultural purposes may be altered but not eliminated. Man made contours will result in microclimatic changes and most likely will affect the post-mining producivity of particular areas. Soil, air and water quality may all be adversely affected on reclaimed areas in the short run.

The surface mined coal will be utilized for electrical generation purposes, proving heat, lights, and so forth. It will also help urban as well as rural power companies to meet SO_x air pollution standards.

Little is known about the effect of surface mining upon subsequent underground mining, however, some feel that the relationship may possibly be negative. Thus surface mining could jeopardize the future removal of coal seams in Area B laying below the Rosebud.

X. DESCRIPTION OF ALTERNATIVE ACTIONS

A. Denial of the Permit Amendment

Denial of the permit amendment for Area B would mean that WECo would continue to mine under their existing permits for Areas A and E. The recoverable coal able to be mined under these permits is limited, however, and WECo would soon be required to submit new permit or permit amendment applications in order to meet contract demands. Denial of this permit would adversely affect the viability of Colstrip electrical generation units 1 and 2 and proposed units 3 and 4. The ultimate result of further permit denials would be the loss of Colstrip-related employment and the termination of the Rosebud mine as a source of low-sulfur coal. Montana Power and the midwestern power companies would have to seek other sources of such coal.

B. Underground Mining

The major advantage of underground mining is that there would be little disturbance of the stratigraphic layers except for the removal of the coal itself. Surface subsidence would occur at Colstrip because "caving" is an integral part of underground coal mining. For every 10 feet of coal removed 100 feet of overlying strata are disturbed by caving.[43]

Frequency rates for both fatal and non-fatal accidents are about 5 times higher for underground than for strip mining. Roof falls and coal falls caused by the low bearing strength of the overlying strata and faults cause many accidents. Accidents in underground mines are also caused from gas and dust build-ups. Also, the long-term hazards from inhalation of coal dust and radioactive particles (in western coals) are great.

The Russians, English and French have developed methods for mining thick (16-24 feet) coal seams with recovery rates to about 80%. But these are applicable to deep seams with stable roof conditions. Recovery rates using conventional and longwall underground mining average 55%, but using these methods on very thick seams would probably reduce this recovery rate. Strip mining has a recovery rate of 95% and even with the excluded areas (buffer zones, etc.) recovery rates average 90%.[43]

Skilled manpower for an underground mine must be obtained either through importing qualified workers or training existing unemployed Montanans. Underground mines require ten times the manpower required by a strip mine. This and the greater capital expenditures makes the final sale price for underground mined coal about seven times that of surface mined coal.

C. Contour, Auger and _In Situ_ Mining

Contour mining is prohibited by the Montana Strip and Underground Mine Reclamation Act.

Auger mining would recover about 10% of the coal resource. This would result in a waste of virgin coal seams because auger mining renders them unsuitable for mining by any other method.

In situ mining, used in the mining of sulfur, potash, and uranium, is a method in which super-heated water or another solvent is pumped into an ore-body and then the resource bearing solution is withdrawn and processed. This method is probably not feasible for coal. There appears to be little technology today to determine whether the coal seams are sufficiently friable to be pumped from the underground as a slurry. No markets for such a product are currently available. Damage to aquifers and other subsurface structures by in situ mining is unpredictable. In situ gasification is still a research concept and not an available alternative.[43]

D. Alteration of Mining and/or Reclamation Plan

Under the Montana Strip and Underground Mine Reclamation Act, the mining and reclamation plan must comply with all aspects of the law before a permit can be granted. Substantial alteration while still allowing surface mining would therefore not change the impact of the operation appreciably.

E. Utilization of Other Forms of Energy

Other fossil fuels such as natural gas and petroleum, are in more limited supply than coal. Oil shales and tar sands are only available on a small scale and are thus not an available alternative at this time.

Nuclear power has encountered technical difficulties in providing adequate safety precautions. Public reaction has also been slowing its development.

Solar, geothermal and wind energy converters are still experimental or pilot plant scale operations. But while such sources show promise, their large scale utilization is still some time in the future.

Hydroelectric generation facilities in this country have utilized almost all available sites. Many hydroelectric dams have had additional power houses built.

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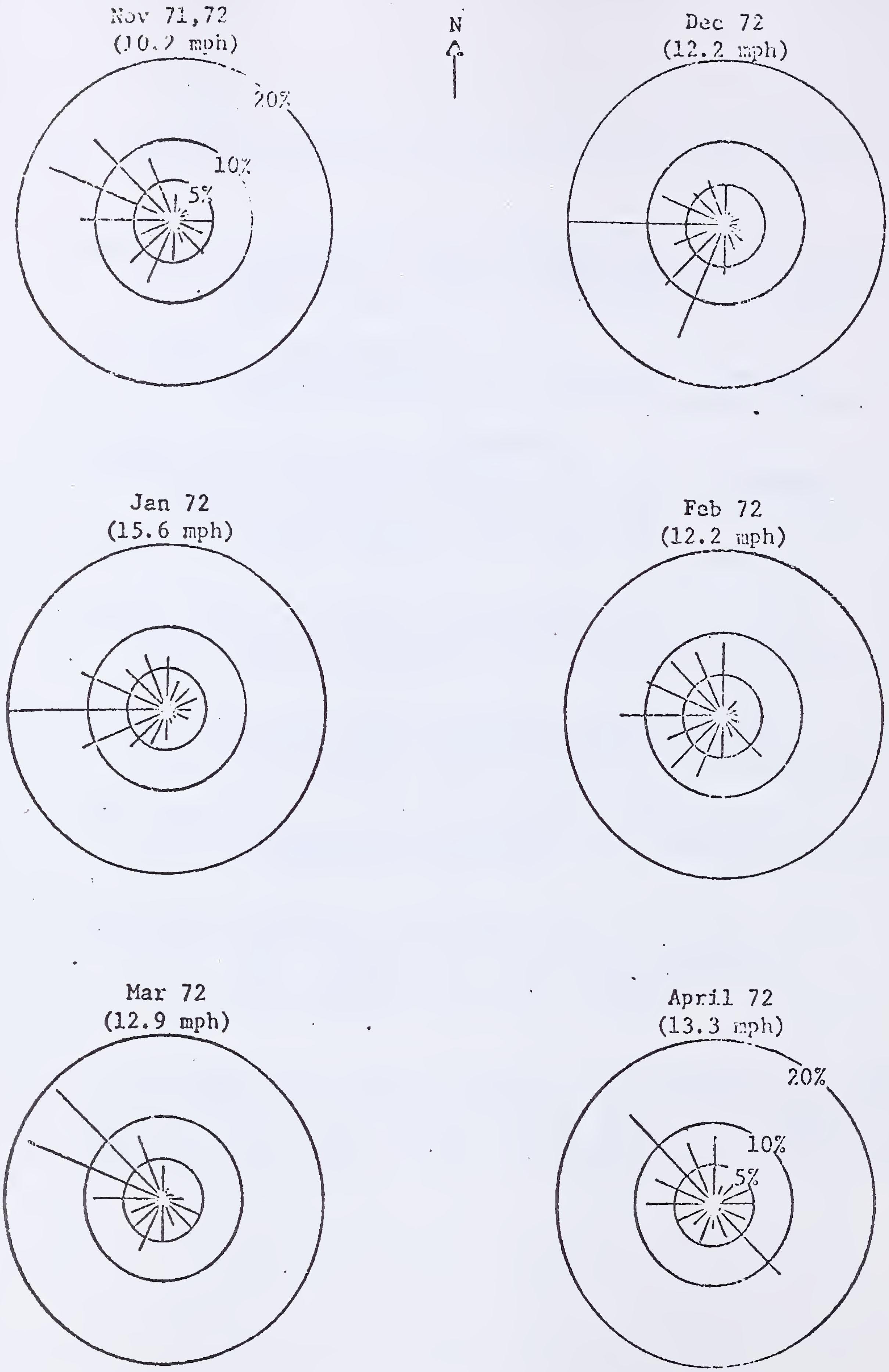
APPENDIX A

Monthly and Seasonal Wind Roses for Colstrip, Montana

Figure 1


Nov 71,72
(10.2 mph)

Dec 72
(12.2 mph)

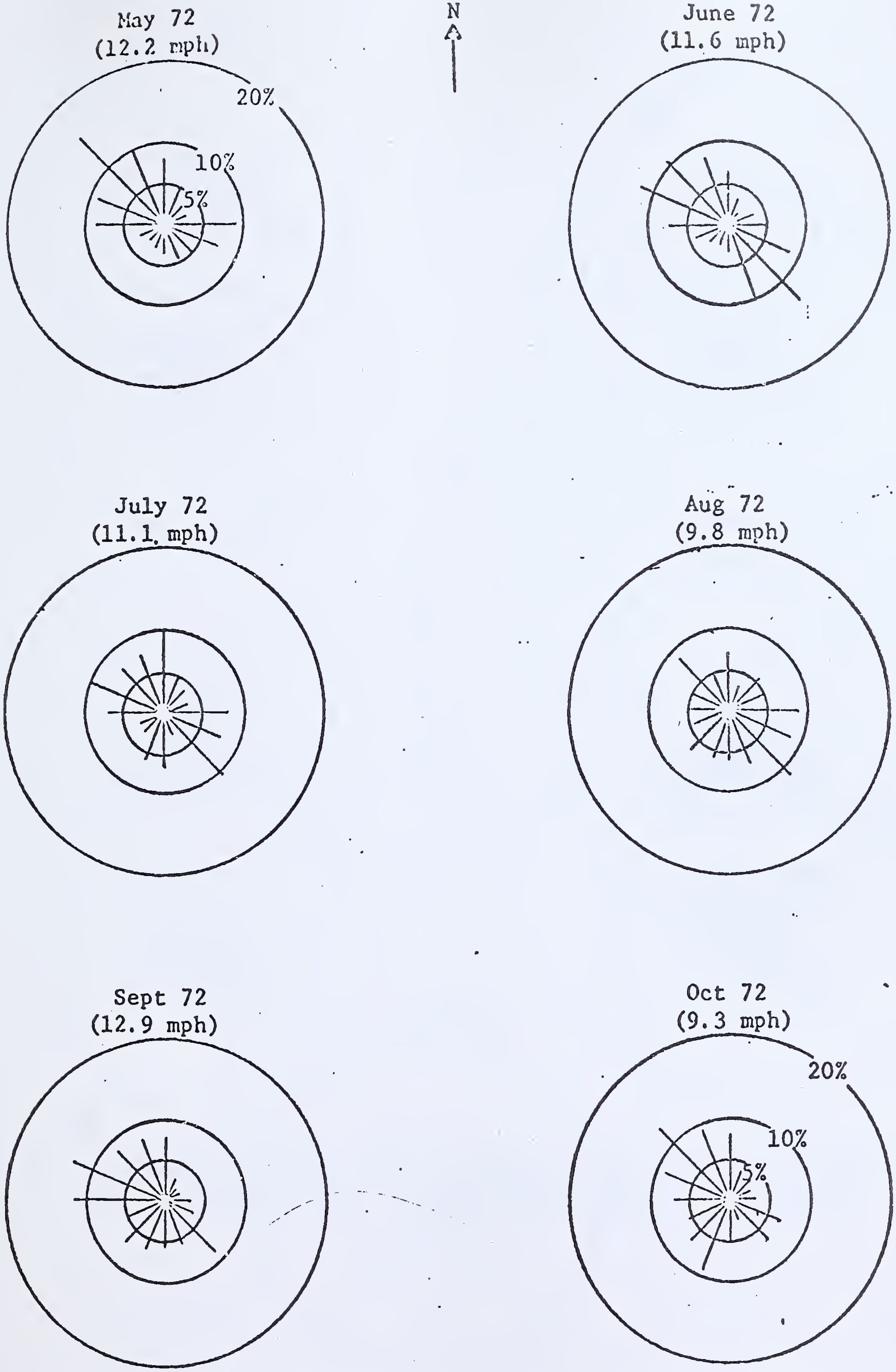
Jan 72
(15.6 mph)

Feb 72
(12.2 mph)

Mar 72
(12.9 mph)

April 72
(13.3 mph)

Fig. 12. Monthly Wind Roses at 307 ft AGL. (Numbers Indicate Mean Wind Speed)



May 72 (12.2 mph)

June 72 (11.6 mph)

July 72 (11.1 mph)

Aug 72 (9.8 mph)

Sept 72 (12.9 mph)

Oct 72 (9.3 mph)

Fig. 13. Monthly Wind Roses at 307 ft AGL. (Numbers Indicate Mean Wind Speed)

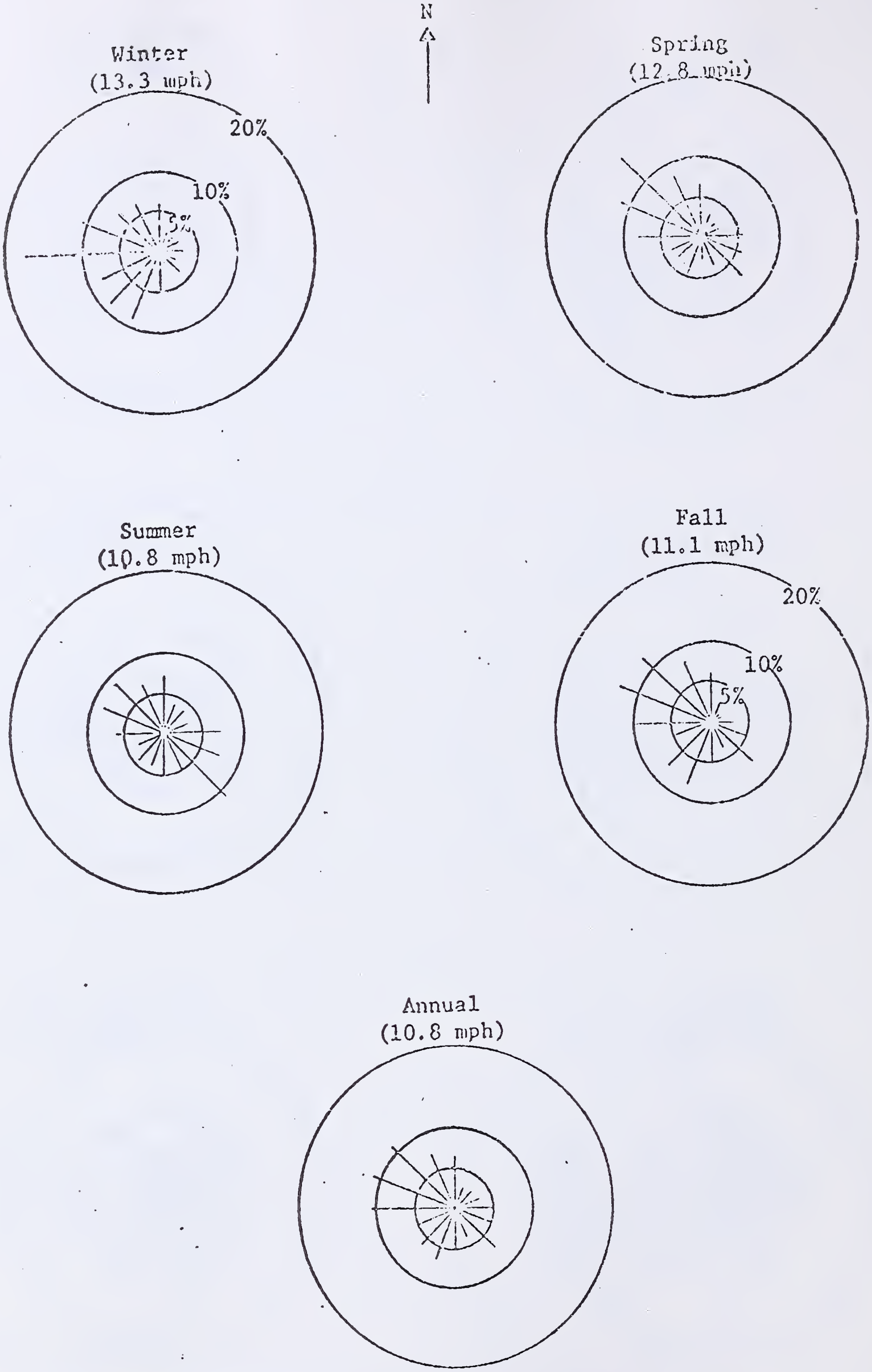
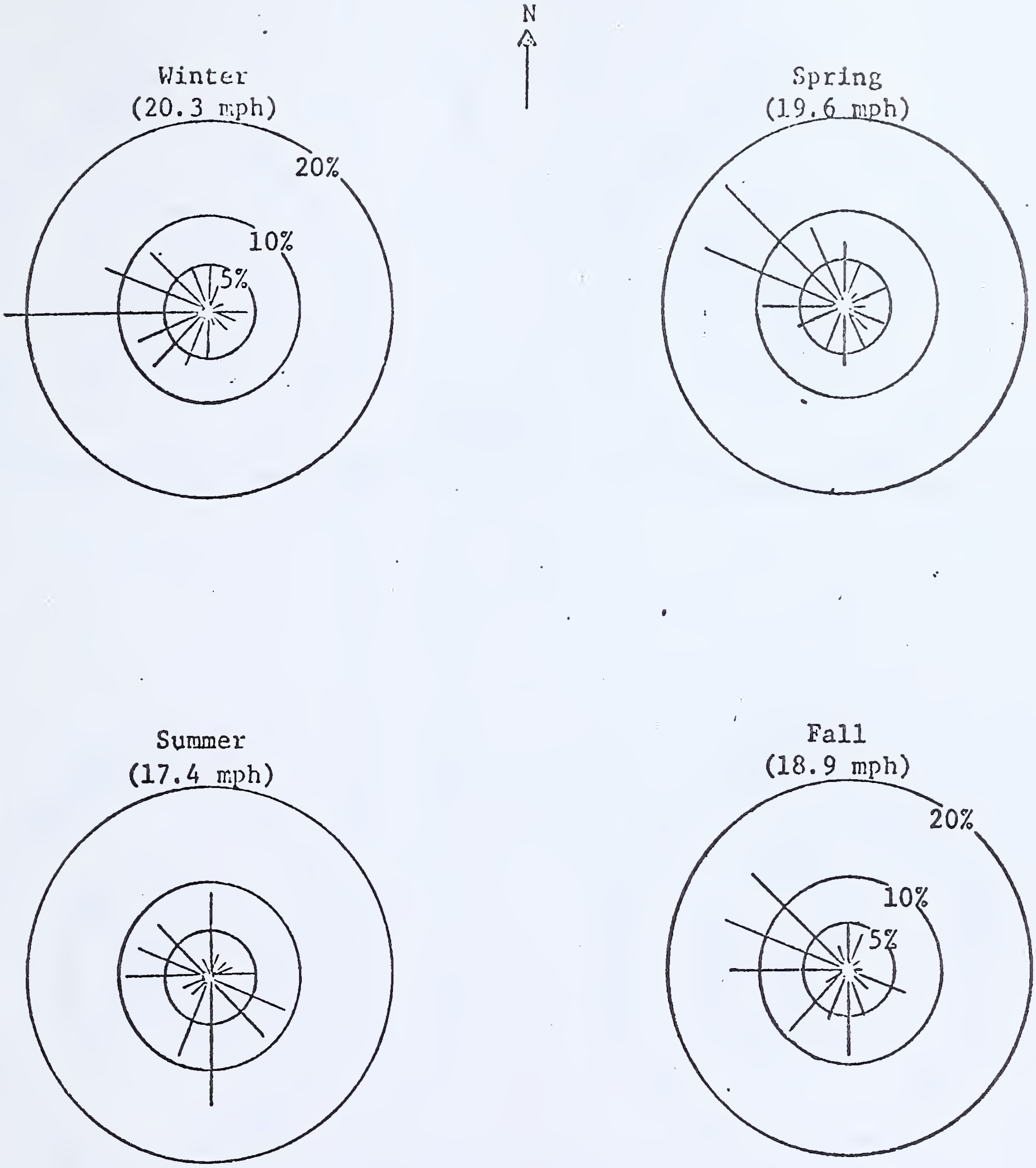


Fig. 14. Seasonal and Annual Wind Roses at 307 ft AGL. (Numbers Indicate Mean Wind Speed)



Winter (20.3 mph)

Spring (19.6 mph)

Summer (17.4 mph)

Fall (18.9 mph)

Fig. 15. Seasonal Wind Roses at 1053 ft AGL Based on All Near Dawn Pilot Balloon Observations. (Numbers Indicate Mean Wind Speed)

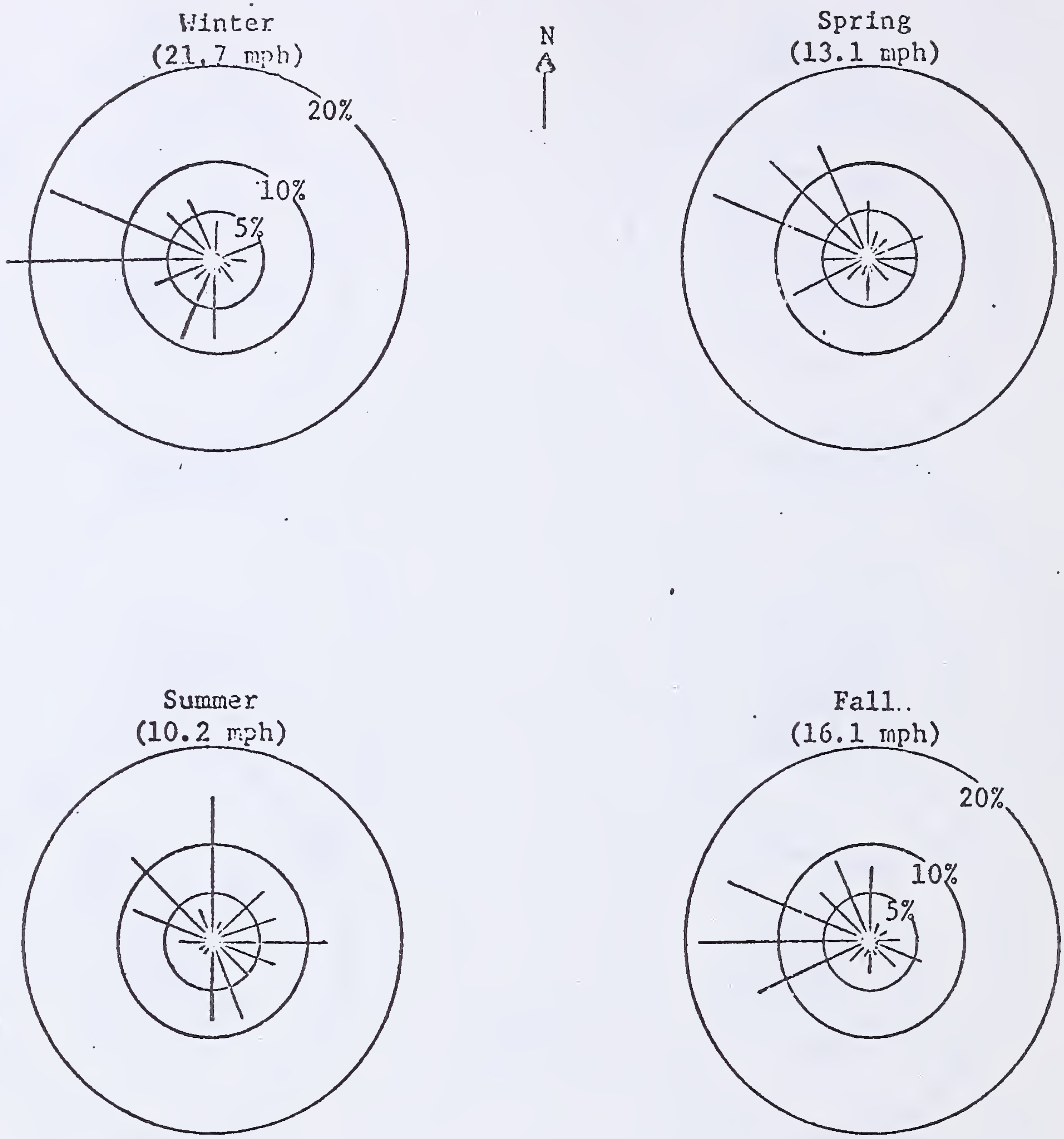


Fig. 16. Seasonal Wind Roses at 1053 ft AGL Based on All Midafternoon Pilot Balloon Observations. (Numbers Indicate Mean Wind Speed)

APPENDIX B

Soil Series Descriptions and Chemical Properties for Mining Area B, Colstrip, Montana

Table 7 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 4 Rainville

Lab No.	Horizon	Depth	pH Paste	Sat'n.	Elect. Cond.	Saturation Extract			
						Cations			
						Ca	Mg	Na	SAR
		inches		%	mmhos/cm	- - - - - meq/liter - - - - -			
7810	A1	0-2	8.2	32.4	0.5	2.50	1.88	0.48	0.32
7811	C1	2-9	7.7	39.7	0.4	2.31	1.88	0.39	0.27
7812	C2	9-22	8.1	14.5	0.5	1.63	3.65	0.91	0.56

Table 8 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

	Mechanical Analysis								
Depth	Clay	Silt	Sand	Texture	Zn	Fe	Cu	Mn	B
inches	%	%	%		ppm	ppm	ppm	ppm	ppm
0-2	23.6	10.4	66.0	SCL	0.03	4.6	1.4	1.2	0.8
2-9	23.2	12.4	64.4	SCL	0.2	6.6	1.4	1.2	0.5
9-22	31.6	31.6	36.8	CL	0.04	7.0	2.0	1.0	0.5

Table 17 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 9 Midway

Lab No.	Horizon	Depth	pH Paste	Sat'n.	Elect. Cond.	Saturation Extract Cations Ca	Mg	Na	SAR
		inches		%	mmhos/cm	- - - - - - meq/liter - - - - - -			
7850	A1	0-3	7.8	38.5	0.6	6.00	2.19	0.48	0.24
7851	C1	3-8	7.9	40.0	0.5	2.50	0.94	0.39	0.30
7852	C2	8-13	8.1	47.3	0.5	1.63	2.19	0.91	0.66

Table 18 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

	Mechanical Analysis								
Depth	Clay	Silt	Sand	Texture	Zn	Fe	Cu	Mn	B
inches	%	%	%		ppm	ppm	ppm	ppm	ppm
0-3	24.0	18.8	57.2	SCL	0.2	3.9	1.0	3.6	1.2
3-8	44.8	26.4	28.8	C	0.2	7.5	1.6	1.2	1.5
8-13	54.4	29.6	16.0	C	0.1	12.8	1.4	1.0	0.6

Table 5 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 3 Fort Collins Loam

Lab No.	Horizon	Depth	pH Paste	Sat'n.	Elect. Cond.	Saturation Extract			
						Cations			
						Ca	Mg	Na	SAR
		inches		%	mmhos/cm	- - - - - - meq/liter - - - - - --			
7802	Ap	0-6	6.7	34.0	0.7	1.25	1.98	0.48	0.38
7803	B2t	6-16	7.1	40.5	0.8	2.13	2.08	0.69	0.48
7804	B3	16-21	7.8	38.2	0.5	1.63	2.29	1.00	0.68
7805	C1ca	21-27	8.1	37.1	1.1	2.50	8.96	2.30	0.99
7806	C2	27-62	8.1	33.3	0.5	1.88	3.13	1.30	0.83

Table 6 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

	Mechanical Analysis								
Depth	Clay	Silt	Sand	Texture	Zn	Fe	Cu	Mn	B
inches	%	%	%		ppm	ppm	ppm	ppm	ppm
0-6	17.2	13.2	69.6	SL	0.9	11.5	1.8	12.8	0.6
6-16	23.6	18.4	58.0	SL	0.02	8.4	1.6	6.7	0.5
16-21	28.4	20.8	50.8	SCL	0.2	8.4	1.6	6.7	0.3
21-27	21.2	21.6	57.2	SCL	0.04	4.6	1.6	1.8	0.7
27-62	14.8	12.0	73.2	SL	0.04	3.0	1.4	1.0	0.2

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Date Sent

RESULTS OF DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing Laboratories, Inc.
P. O. Box 3048
Great Falls, Montana 59404

FOR: (Grower) Western Energy

REMITT

CLIENT: (Dealer)

Lab No.	Your Field No.	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	Available H2O (Inches)
9010		0-14	7.7	1.0	0.25		14.5	203	10.0	5.0	0.1	0.5	FSL+	O
9011		14-29	7.9	0.5	0.25		12.5	86	32.4	3.8	0.1	0.3	FSL	M
9012		29-50	7.9	0.08	0.25		17.5	63	34.1	7.1	0.1	0.4	FSL+	M
9013		50-72	8.2	0.08	0.25		7.7	2.5	21.5	7.3	0.1	0.4	FSL+	M+

63

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others
3.4	0	7.0	2.3	10.0		11.8	5.9			26.8	34.4	38.8	L
0	0	4.9	1.4	5.2		9.06	4.53			14.8	30.4	54.8	SL
0	0	3.8	1.4	3.2		9.59	4.79			15.8	3.4	80.8	SL
0.7	0	3.0	1.1	1.4		9.59	4.79			15.8	2.4	81.8	SL

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RESULTS OF
DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing Laboratories, Inc.
P. O. Box 3048
Great Falls, Montana 59404

FOR: (Grower) Western Energy
HELDT

CLIENT: (Dealer)

Lab No.	Your Field No.	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	LIME
9106		0-6	8.3	2.7	1.85	3.7	14.5	213	7.5	3.2	0.1	0.4	FSL	M
9107		6-22	8.4	1.2	0	0	62.0	88	19.4	3.0	0.1	0.3	L+	M+
9108		22-34	8.5	0.6	0	0	12.5	88	+35	7.3	0.1	0.5	SiL	M+
9109		34-44	8.6	0.08	0	0	12.5	63	29.3	9.2	0.1	0.9	L	M
9110		44-64	8.3	0.08	0	0	21.0	63	29.3	6.2	0.5	2.9	SiL	0

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum SAR	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others texture
	0.05	4.0	1.6	10.8		18.58	9.29	2.77		30.8	30.4	38.8	CL
	0	4.6	1.8	4.8		17.26	8.63	0.33		28.8	20.4	52.8	SCL
	0	5.2	2.0	3.6		19.5	9.75	0.32		32.8	26.4	40.8	CL
	0	7.0	1.6	2.8		18.38	9.19	1.22		30.8	24.4	44.8	SCL
	0	4.9	1.4	2.4		11.42	5.71	0.72		16.8	28.4	64.8	SL

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RESULTS OF
DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing Laboratories, Inc
P. O. Box 3013
Great Falls, Montana 59401

: Western Energy
wer)

McRae

CLIENT:
(Dealer)

No.	Your Field No.	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	Available H₂O (Inches)
														LIME
035		0-6	7.9	2.9	22.95		17.5	213	20.3	5.3	0.1	0.6	SiCL-	M-
036		6-16	8.2	0.9	7.5		5.0	88	+35	8.0	0.1	0.5	L	M+
037		16-24	8.3	0.1	1.85		5.0	63	+35	11.9	0.1	0.5	L+	M+
038		24-36												
039		36-66	9.0	0.1	0.25		21.0	2.5	34.1	8.0	1.0	0.6	L	M

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	Mechanical Analysis % Silt	Mechanical Analysis % Sand	Others
													Texture
38	0.05	5.8	1.6	4.8		10.57	9.29			30.8	50.4	18.8	SiCL
4.1	0	5.5	2.0	5.2		11.78	5.89			26.8	34.4	38.8	L
43.4	0.3	4.6	1.8	2.8		14.92	7.46			24.8	46.4	28.8	L
18.2	0	4.0	1.2	3.4		7.96	3.93			12.8	48.4	38.8	L

Table 1 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 1 Thurlow Silty Clay Loam

Lab No.	Horizon	Depth	pH Paste.	Sat'n.	Elect. Cond.	Saturation Extract Cations Ca	Mg	Na	SAR
		inches		%	mmhos/cm	- - - - - - meq/liter - - - - - -			
7791	Ap	0-5	7.4	35.8	0.7	0.03	0.31	0.09	0.16
7792	B1	5-8	7.1	36.7	1.4	0.3	12.5	2.83	1.12
7793	B2t	8-12	7.4	40.3	0.8	2.31	4.5	0.91	0.49
7794	B3	12-17	8.1	46.6	1.6	3.75	11.3	3.61	1.32
7795	C1ca	17-24	8.4	51.5	11.4	2.25	165.0	40.4	4.42
7796	C2	24-30	8.5	48.1	12.6	0.45	184.0	45.7	4.76
7797	C3	30-65	8.6	34.8	16.0	0.65	263.0	64.7	5.63

Table 2 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

Depth	Mechanical Analysis % Clay	% Silt	% Sand	Texture	Zn	Fe	Cu	Mn	B
inches					ppm	ppm	ppm	ppm	ppm
0-5	17.2	18.0	64.8	SL	1.1	9.2	1.4	8.9	1.1
5-8	25.2	8.4	66.4	SL	0.9	9.2	2.6	8.6	0.5
8-12	5.6	9.2	85.2	LS	0.1	8.0	1.8	1.2	0.5
12-17	36.8	20.8	42.4	L	0.03	4.4	1.6	1.2	0.7
17-24	2.0	64.8	33.2	SiL	0.2	6.0	2.0	1.0	1.0
24-30	1.2	68.8	30.0	SiL	0.2	5.8	1.4	1.2	1.4
30-65	2.8	33.6	63.6	SL	0.03	3.9	1.4	1.0	1.5

Table 3 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 2 Tullock

Lab No.	Horizon	Depth inches	pH Paste	Sat'n. %	Saturation Extract Elect. Cond. mmhos/cm	Cations Ca	Mg	Na	SAR
						- - - - - meq/liter- - - - - -			
7798	A1	0-4	7.9	31.8	0.6	1.5	1.46	0.39	0.20
7799	B1	4-9	7.4	27.3	0.4	0.5	1.67	0.48	0.46
7800	C1	9-21	7.5	26.7	0.4	1.0	1.25	0.39	0.37
7801	C2	21-38	8.1	27.1	0.3	0.75	1.88	0.70	0.61

Table 4 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

	Mechanical Analysis								
Depth inches	Clay %	Silt %	Sand %	Texture	Zn ppm	Fe ppm	Cu ppm	Mn ppm	B ppm
0-4	11.2	6.4	82.4	SL	0.3	7.0	1.2	5.2	0.5
4-9	10.4	7.2	82.4	LS	0.04	5.5	1.0	4.0	0.4
9-21	11.6	10.8	77.6	SL	0.01	3.8	1.0	2.8	0.2
21-38	8.0	8.4	83.6	LS	0.04	2.4	1.4	1.4	0.5

BAINVILLE SERIES

The Bainville series consists of moderately deep, well drained soils formed in place from weathered, soft shale and sandstone. They occupy uplands having slope range of four to 75 percent.

In a representative profile the surface layer is light olive gray loam about two inches thick. The substratum is light olive gray to pale olive loam or silt loam. The soil rests on shoft shale at about 22 inches.

Typifying Pedon

A_1 0-2 inches, light olive gray (5Y 6/2) loam, olive (5Y 4/3) moist; weak, fine crumb structure; slightly hard, friable; slightly sticky and slightly plastic; many fine roots; clear, wavy boundary.

C_1 2-9 inches, light olive gray (5Y 6/2) loam, olive (5Y 4/3) moist; weak, fine and medium blocky structure; hard, friable, sticky and plastic; weak effervescence; common fine roots; five percent of volume is shale and sandstone chips; gradual, wavy boundary.

C_2 9-22 inches, pale olive (5Y 6/3) heavy silt loam, olive (5Y 5/3) moist; weak, coarse prismatic structure; hard, friable, sticky and plastic; strong effervescence; common coarse lime mottles; ten percent of volume is flat shale chips; irregular boundary.

CR 22+ inches, platy shale and sandstone.

Location: 350' W & 250' N of ¼ corner Sec. 9 & 10; T1N, R41E.

Laboratory Sample #4

Depth to shale ranges from 20 to 36 inches. Coarse fragments cover zero to 25 percent of the surface. The profile contains zero to 60 percent coarse fragments of shale and sandstone with greatest concentrations immediately above the bedrock.

MIDWAY SERIES

The Midway series consists of shallow, well drained soils formed in place from soft platy clayey shale. They occupy uplands with slopes ranging from four to 50 percent.

In a representative profile the surface layer is pale olive silty clay loam about three inches thick. Below this is pale yellow silty clay loam that merges with soft, clayey shale at about 13 inches.

Permeability is moderately slow, and runoff is moderately rapid to rapid.

Typifying Pedon

A_1 0-3 inches, pale olive (5Y 7/3) heavy silty clay loam, olive (5Y 4/3) moist; moderate, medium platy structure; hard, friable, sticky and plastic; common fine roots; weak effervescence; clear, wavy boundary.

C_1 3-8 inches, pale yellow (5Y 7/3) heavy silty clay loam, olive (5Y 4/3) moist; weak, coarse prismatic structure; hard, firm, very sticky and very plastic; strong effervescence; many fine roots; clear, wavy boundary.

C_2 8-13 inches, pale yellow (5Y 7/3) heavy silty clay loam, olive (5Y 5/3) moist; weak, coarse prismatic structure parting to weak, fine blocks; hard, firm, very sticky and very plastic; strong effervescence; a few medium lime mottles; many very fine roots; 20 percent of volume is shale chips; clear, irregular boundary.

R 13+ inches, platy shale.

Location: 30' N & 200' W of ¼ corner, Sec. 9 & 10, T1N, R41E.

Laboratory Sample #9

Depth to bedrock ranges from ten to 20 inches. Coarse fragments cover zero to 20 percent of the surface and make up zero to 60 percent of the profile, with greatest concentrations immediately above the bedrock.

FORT COLLINS SERIES

The Fort Collins series consists of deep, well drained soils formed from alluvium washed from soft sandstone, loam and siltstone uplands. They occupy fans and footslopes. In a representative profile the surface layer is grayish brown loam about six inches thick. The subsoil is grayish brown to olive gray clay loam about 14 inches thick. Below this is calcareous olive and pale olive loam to 60 or more inches. Slopes are four to eight percent. The permeability is moderate and runoff is medium.

Typifying Pedon

Fort Collins Loam, Five Percent Slope

A_1 0-4 inches, graying brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; moderate, very thin platy structure; hard, friable, slightly sticky and plastic; common fine and very fine roots; clear, smooth boundary.

B_1 4-6 inches, grayish brown (2.5Y 5/2) light clay loam, dark grayish brown (2.5Y 4.2) moist; moderate, coarse prismatic structure; hard, friable, sticky and plastic; common fine and very fine roots; clear, wavy boundary.

B_{2t} 6-14 inches, grayish brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) moist; moderate, medium and coarse prismatic structure parting to moderate, medium blocks; very hard, firm, very sticky and plastic; common fine and very fine roots; gradual, wavy boundary.

B_3 14-20 inches, pale olive (5Y 6/3) light clay loam, olive (5Y 5/3) moist; weak, medium prismatic structure parting to weak, medium blocks; very hard, firm, sticky and plastic; weak effervescence; a few fine lime mottles; a few very fine roots; clear, wavy boundary.

C_{1ca} 20-25 inches, pale yellow (5Y 7/3) light loam, pale olive (5Y 6/4) moist; massive; hard, friable, sticky and plastic; strong effervescence, common fine lime mottles; a few very fine roots; gradual, wavy boundary.

C_2 25-60 inches, pale olive (5Y 6/3) light loam, olive (5Y 5/4) moist; massive; hard, friable, slightly sticky and plastic; strong effervescence; a few fine lime mottles; a few very fine roots.

Location: 400' S and 85' W of ¼ corner, Sec. 8 & 9; T1N, R41E.

Laboratory Sample #5

Texture in the upper three feet ranges from light loam to heavy clay loam. At depths below three feet, stratification includes textures of silt loam and fine sandy loam.

REMITT SERIES

The Remitt series consists of deep, well drained, moderately sloping and gently rolling soils on fans and footslopes. These soils are formed in sandy alluvium and aeolean sands. Annual precipitation is ten to 14 inches.

In a typical profile the surface layer and subsoil are grayish-brown fine sandy loams about 12 inches thick. The substratum is light yellowish brown, stongly calcareious fine sandy loam.

Permeability is moderately rapid, and runoff is slow.

Typifying Pedon

Remitt fine sandy loam, four to eight percent slopes:

Ap-0-6 inches, grayish-brown (2.5y 5/2) fine sandy loam, dark grayish-brown (2.5y 4.2) moist; weak fine crumb structure; soft when dry, very friable when moist; nonsticky and nonplastic when wet; weak effervescence; abrupt wavy boundary.

B2-6-12 inches, grayish-brown (10yR 5/2) fine sandy loam, dark brown (10yR 4/3) moist; weak coarse prismatic structure; soft when dry, very friable when moist; nonsticky and nonplastic when wet; common fine and very fine and few medium roots, common fine and very fine pores; strong effervescence; clear wavy boundary.

Clca-12-36 inches, light yellowish-brown (2.5y 6/3) fine sandy loam, light olive brown (2.5y 5/4) moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic wet; common fine and very fine roots; common fine and very fine pores; strong effervescence and few fine, faint threads and masses of line; diffused boundary.

C2-36-60 inches, light yellowish-brown (2.5 6/3) fine sandy loam light olive brown (2.5y 5/4) when moist; massive; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; strong effervescence.

HELDT SERIES

The Heldt Series consists of deep, well drained calcareous soils formed in alluvium. They occupy fans. Slopes range from two to eight percent. Annual precipitation is ten to 14 inches.

In a representative profile the surface layer is grayish-brown silty clay loam about six inches thick. The subsoil is light grayish brown silty clay loam about 16 inches thick. The underlying material is pale brown heavy loam or clay loam.

Permeability is slow and runoff is medium.

Typifying Pedon

Heldt silty clay loam, 2 to 8 percent slope:

A1 0-6 inches, dark grayish-brown (10yR 4/2) moist; silty clay loam; moderate fine granular structure; slightly hard when dry, friable when moist; and sticky when wet.

B2 6-22 inches, grayish-brown (10yR 5/2) moist; silty clay loam; coarse blocky structure; hard when dry, friable when moist; and sticky when wet; strong effervescence; small nodules and fine threads of segregated lime.

C1 22-34 inches, pale-brown (10yR 6/3) moist; heavy loam; massive; hard when dry, driable when moist and slightly sticky when moist; strong effervescence.

C2 34-44 inches, pale-brown (10yR 6/3) moist; heavy loam; massive; hard when dry; friable when moist and slightly sticky when wet; strong effervescence.

C3 44-60 inches; brown (10yR 5/3) moist; sandy loam; massive; slightly hard when dry, very friable when moist and nonsticky when wet; strong effervescence.

MCRAE SERIES

The McRae series consists of deep, well drained nearly level to moderately sloping, calcareous soils on fans and terraces. These soils are formed in loamy alluvium. Annual precipitation is ten to 14 inches.

In a typical profile the surface layer and subsoil are light brownish-gray loam about 12 inches thick. The substratum is light gray loam and fine sandy loam. It is strongly calcareous and contains light gray masses of lime.

Permeability is moderate, and runoff is medium.

Typifying Pedon

McRae loam, 4 to 8 percent slopes:

Ap-0-6 inches, light brownish-gray (2.5y 6/2) loam, dark grayish-brown (2.5y 4.2) moist; moderate fine crumb structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; strong effervescence; abrupt wavy boundary.

B2-6-12 inches, light brownish-gray (2.5y 6/2) loam, olive brown (2.5y 4/4) moist; moderate medium prisms that separate to weak medium and fine subangular blocks; slightly hard, friable, slightly sticky and plastic; common fine and very fine and few medium roots; many fine and very fine pores; strong effervescence; clear wavy boundary.

B3ca-12-20 inches, pale-yellow (2.5y 7/3) loam, light olive-brown (2.5y 5/4) moist; weak coarse subangular blocks; hard, friable, slightly sticky and plastic; common fine and very fine roots; common fine and very fine pores; strong effervescence with common faint masses and threads of lime; diffused boundary.

Clca-20-24 inches, pale-yellow (2.5y 7/3) loam, light olive-brown (2.5y 5/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine roots; many fine and very fine pores; strong effervescence; few faint masses and threads of lime; gradual boundary.

C2-24-60 inches, pale-yellow (2.5y 7/3) fine sandy loam, olive-brown (2.5y 4/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few fine and very fine roots; strong effervescence.

THURLOW SERIES

The Thurlow series consists of deep, well drained, gently sloping to nearly level soils on terraces, fans, and footslopes. They formed in clayey alluvium washed from mixed shale and silt stone uplands.

In a typical profile the plowed layer is grayish brown heavy silt loam about five inches thick. The subsoil is grayish brown to light yellowish brown heavy silty clay loam, about 12 inches thick. The calcareous substratum is light yellowish brown to light gray silty clay loam to 60 or more inches.

Permeability is moderately slow, and runoff is medium to low.

Typifying Pedon

Thurlow Silty Clay Loam, one percent slope:

A_p 0-5 inches, grayish brown (2.5Y 5/2) heavy silt loam, very dark grayish brown (2.5Y 3/2) moist; massive; hard, friable, sticky and plastic; many fine and very fine roots; clear, smooth boundary.

B_1 5-8 inches, grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate, medium prismatic structure; hard, firm, sticky and plastic; many fine and very fine roots; clear, smooth boundary.

B_{2t} 8-12 inches, grayish brown (2.5Y 5/3) heavy silty clay loam, dark grayish brown (2.5Y 4.2) moist; moderate, medium prismatic structure parting to moderate, medium and fine blocks; very hard, firm, sticky and plastic; many fine and very fine roots; clear, wavy boundary.

B_3 12-17 inches, light yellowish brown (2.5Y 6/3) heavy silty clay loam, light olive brown (2.5Y 5/4) moist; moderate, medium prismatic structure parting to strong, fine blocks; very hard, firm, very sticky and plastic; common very fine roots; weak effervescence; gradual, wavy boundary.

C_{1ca} 17-24 inches, light yellowish brown (2.5Y 6/3) heavy silty clay loam, light olive brown (2.5Y 5/4) moist; weak, medium prismatic structure parting to weak, medium blocks; very hard, firm, very sticky and very plastic; strong effervescence; common very fine roots; gradual wavy boundary.

C_2 24-30 inches, light gray (2.5Y 7/3) silty clay loam, light yellowish brown (2.5Y 6/4) moist; weak, medium prismatic structure parting to weak, medium blocks; hard, firm, sticky and plastic; strong effervescence; common fine roots; clear wavy boundary.

TULLOCK SERIES

The Tullock series consists of moderately deep, well to somewhat excessively drained, sloping to moderately steep soils on sandstone uplands.

In a typical profile the surface layer is grayish brown fine sandy loam, about four inches thick. The substratum is fine sandy loam to about 38 inches. The soil rests on sandstone at depths between 20 and 40 inches.

The permeability is moderately rapid and the runoff is low.

Typifying Pedon

Tullock Fine Sandy Loam, eight percent slope:

A_1 0-4 inches, grayish brown (10YR 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) moist; weak, coarse crumb structure; slightly hard, very friable, nonsticky and slightly plastic; common fine and very fine roots; clear, smooth boundary.

B_1 4-9 inches, grayish brown (10YR 5/2) heavy sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; clear, wavy boundary.

C_1 9-21 inches, brown (10YR 5/3) light sandy loam, dark grayish brown (10YR 4/2) moist; weak, coarse prismatic structure, slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; clear, wavy boundary.

C_2 21-38 inches, light yellowish brown (2.5Y 6/3) light sandy loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, very friable, nonsticky and slightly plastic; weak effervescence; a few very fine roots; gradual, wavy boundary.

38+ inches, soft sandstone.

Location: 235' W and 25' No of ¼ corner, Sec. 7 & 8; T1N, R41E.

Laboratory Sample #2

Profile texture ranges from sandy loam to loamy fine sand. Content of coarse sandstone fragments ranges from zero to 30 percent.

Red Rock Outcrop Complex Steep (Sb)

This complex comprises red rock outcrops and steep soils on uplands. About 60 percent is red rock outcrop and about 20 percent is Remitt fine sandy loam, red phase.

Included in mapping is about 20 percent soils that are 1- to 20 inches deep from red bedrock. The Remitt soil has a typical profile for the series, except that it is red in color.

Risk of erosion is moderate for water and wind.

None of this very shaley, channery and gravelly loam material is suitable for stockpiling. The isolated pockets of Remitt soils are so small, discontinuous, and of such steep slopes that they are impractical to excavate by conventional methods. Material coarser than three inches makes up to 30 to 75 percent of the volume of the identifiable soils in these areas.

APPENDIX C

Analysis of Coal Overburden and Interburden for Mining Area B, Colstrip, Montana

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CHEMICAL ANALYSIS OF INNERBURDEN AND OVERBURDEN
WESTERN ENERGY COMPANY
COLSTRIP, MONTANA

Sample Location	Depth	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Sub-Surface Formation
Overburden N47 E57	10'- 20'	45748	8.1	6.48	33.6	28.70	0.96	40.30	1.35	33.90	1.14	5.78	Clay Loam	Lt. Brown Sandy Shale
Overburden N47 E57	20'- 30'	45749	8.1	3.67	35.1	9.88	0.35	19.20	0.67	17.37	0.61	4.56	Clay Loam	Lt. Brown Shale
Overburden N47 E57	30'- 40'	45750	8.2	2.75	31.6	7.55	0.24	14.60	0.46	10.87	0.34	3.26	Loam	Lt. Brown Sandy Shale
Overburden N47 E57	40'- 50'	45751	8.6	1.78	25.5	5.29	0.13	7.56	0.19	5.45	0.14	2.15	Sandy Loam	Lt. Brown Sandstone
Overburden N47 E57	50'- 60'	45752	8.4	0.81	28.3	3.55	0.10	5.40	0.15	2.68	0.08	1.26	Loamy Sand	Lt. Brown Sandstone
Overburden N47 E57	60'- 70'	45753	8.4	0.86	26.4	4.64	0.12	4.18	0.11	3.14	0.08	1.50	Sandy Loam	Lt. Brown Sandstone
Overburden N47 E57	70'- 80'	45754	8.5	1.89	27.4	7.72	0.21	11.62	0.32	7.19	0.20	2.31	Sandy Loam	Lt. Brown Sandstone
Innerburden N47 E57	110'-120'	45755	7.5	1.67	40.3	8.32	0.34	6.66	0.27	6.73	0.27	2.46	Silty Clay Loam	Gray Shale
Innerburden N47 E57	120'-125'	45756	7.5	1.67	39.8	8.22	0.33	6.92	0.28	7.25	0.29	2.64	Silty Clay Loam	Gray Shale

*Oven Dry Soil

**U. S. Department of Agriculture Soil Textural Triangle

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Sample Location	Depth	Lab No.	pH	Conductivity mmhos/ cm	Saturation %	Calcium meq/ Liter	Calcium meq/ 100 grams*	Magnesium meq/Liter	Magnesium meq/ 100 grams*	Sodium meq/ liter	Sodium meq/ 100 grams*	SAR	Texture**	Probable Sub-Surface Formation
Overburden N45 E59	55'- 60'	45733	8.4	2.48	36.9	6.51	0.24	16.23	0.60	5.75	0.21	1.71	Silt Loam	Lt. Brown Shale
Overburden N45 E59	60'- 70'	45734	8.5	2.16	31.2	6.05	0.19	14.40	0.45	4.55	0.14	1.42	Silt Loam	Lt. Brown Sandy Shale
Overburden N45 E59	70'- 80'	45735	8.5	1.30	29.1	3.67	0.11	5.94	0.17	2.38	0.07	1.09	Sandy Loam	Lt. Brown Sandstone
Overburden N45 E59	80'- 90'	45736	8.2	2.16	28.2	9.20	0.26	12.14	0.34	4.22	0.12	1.29	Sandy Loam	Gray Sandstone
Overburden N45 E59	90'-100'	45737	8.2	2.16	32.4	8.69	0.28	13.88	0.45	3.78	0.12	1.13	Loam	Gray Sandy Shale
Overburden N45 E59	100'-103'	45738	7.2	3.02	40.3	14.78	0.60	16.40	0.66	7.98	0.32	2.02	Clay Loam	Gray Shale
Innerburden N45 E59	122'-132'	45739	7.7	2.59	27.3	16.24	0.44	13.30	0.36	9.60	0.26	2.50	Silt Loam	Gray Sandy Shale
Innerburden N45 E59	132'-142'	45740	7.3	2.70	37.0	12.99	0.48	13.80	0.51	10.80	0.40	2.95	Silty Clay Loam	Gray Shale
Overburden N47 E55	0'- 10'	45741	8.5	0.41	24.2	2.01	0.05	2.27	0.05	0.74	0.02	0.51	Loamy Sand	Lt. Brown Sandstone
Overburden N47 E55	10'- 20'	45742	8.5	0.59	22.3	1.54	0.03	3.38	0.08	0.97	0.02	0.62	Sandy Loam	Lt. Brown Sandstone
Overburden N47 E55	20'- 30'	45743	8.0	1.19	27.2	5.27	0.14	6.88	0.19	1.04	0.03	0.42	Loam	Gray Sandy Shale
Innerburden N47 E55	52'- 62'	45744	7.5	2.16	36.5	10.27	0.37	12.94	0.47	3.23	0.12	0.95	Clay Loam	Dark Gray Sandy Shale
Innerburden N47 E55	62'- 72'	45745	7.9	1.84	36.0	7.21	0.26	8.79	0.32	3.55	0.13	1.25	Loam	Gray Sandy Shale
Innerburden N47 E55	72'- 80'	45746	8.1	1.84	32.7	6.87	0.22	8.48	0.28	3.77	0.12	1.36	Loam	Gray Sandy Shale
Overburden N47 E57	0'- 10'	45747	8.0	5.94	34.0	25.30	0.86	27.80	0.95	31.20	1.06	6.06	Loam	Lt. Brown Topsoil

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COLSTRIP, MONTANA

Sample ocation	Depth	Lab No.	pH	Conductivity mmhos/ cm	Saturation %	Calcium meq/ Liter	Calcium meq/ 100 grams*	Magnesium meq/Liter	Magnesium meq/ 100 grams*	Sodium meq/ Liter	Sodium meq/ 100 grams*	SAR	Texture**	Probable Sub-Surface Formation
burden N45 E55	0'- 10'	45704	9.5	4.97	27.9	40.20	1.12	21.30	0.59	16.25	0.45	2.93	Sandy Clay Loam	Lt. Brown Sandstone
burden N45 E55	10'- 20'	45705	8.6	5.94	32.4	33.80	1.10	43.30	1.40	24.30	0.79	3.91	Clay Loam	Lt. Brown Sandy Shale
burden N45 E55	20'- 30'	45706	9.4	4.32	40.5	36.50	1.48	15.60	0.63	14.10	0.57	2.76	Silty Clay Loam	Lt. Brown Shale
burden N45 E55	30'- 40'	45707	8.3	4.64	45.3	25.20	1.41	30.10	1.36	10.80	0.49	2.05	Silty Clay Loam	Gray Shale
burden N45 E55	40'- 50'	45708	8.6	3.67	38.6	22.70	0.88	17.10	0.66	8.45	0.33	1.89	Silty Clay Loam	Gray Shale
burden N45 E55	50'- 60'	45709	8.2	3.56	35.7	19.43	0.69	19.10	0.68	7.85	0.28	1.79	Silt Loam	Gray Shale
burden N45 E55	60'- 70'	45710	8.6	4.00	42.9	39.10	1.68	11.28	0.48	8.40	0.36	1.67	Clay Loam	Gray Shale
burden N45 E55	70'- 80'	45711	8.4	2.97	33.3	18.80	0.63	13.48	0.45	6.21	0.21	1.54	Silt Loam	Gray Sandy Shale
burden N45 E55	80'- 90'	45712	9.3	2.81	39.1	23.90	0.93	4.54	0.18	5.75	0.22	1.53	Silty Clay Loam	Gray Shale
rburden N45 E55	112'-120'	45713	7.5	2.27	42.0	11.30	0.47	9.83	0.41	5.25	0.22	1.62	Silty Clay Loam	Gray Shale
rburden N45 E55	120'-130'	45714	9.6	2.16	45.7	18.10	0.83	1.02	0.05	6.25	0.29	2.02	Silty Clay Loam	Gray Shale
rburden N45 E55	130'-136'	45715	8.0	2.43	41.4	12.68	0.53	7.66	0.32	6.40	0.27	2.01	Silty Clay Loam	Gray Shale
burden N45 E57	0'- 10'	45716	8.1	4.86	30.9	28.90	0.89	37.80	1.17	15.63	0.40	2.71	Loam	Lt. Brown Topsoil
burden N45 E57	10'- 20'	45717	8.1	0.65	58.0	2.85	0.17	4.38	0.25	1.48	0.09	0.78	Clay	Lt. Brown Shale
burden N45 E57	20'- 30'	45718	8.1	0.76	46.5	3.42	0.16	4.99	0.23	1.71	0.08	0.83	Silty Clay	Lt. Brown Shale

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WESTERN ENERGY COMPANY
COLSTRIP, MONTANA

All in Parts Per Million
(-) Indicates Less Than Given Value

Sample Location		Depth	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
Overburden	N45E59	50'- 55'	45732	0.00	31	2.21	0.04	0.10	0.009	2.3	60	6.2	2.1	-0.10	2.9	0.7
Overburden	N45E59	55'- 60'	45733	0.00	15	1.51	0.03	0.11	0.008	1.3	28	3.8	1.2	-0.10	2.0	0.1
Overburden	N45E59	60'- 70'	45734	0.00	22	1.68	0.02	0.11	0.009	1.1	17	2.5	0.5	-0.10	0.8	0.1
Overburden	N45E59	70'- 80'	45735	1.79	13	1.31	0.02	0.11	0.012	2.0	28	2.9	0.4	-0.10	0.8	0.1
Overburden	N45E59	80'- 90'	45736	0.00	11	1.44	0.02	0.20	0.013	2.1	60	5.0	0.5	-0.10	2.9	0.4
Overburden	N45E59	90'-100'	45737	0.00	9	2.04	0.01	0.20	0.015	3.2	24	3.5	1.7	-0.10	3.9	0.8
Overburden	N45E59	100'-103'	45738	1.15	26	4.49	0.02	0.13	0.050	4.4	36	3.9	2.4	-0.10	4.8	1.5
Innerburden	N45E59	122'-132'	45739	0.81	7	1.68	0.01	0.50	0.051	2.2	52	10.0	1.9	-0.10	2.0	0.6
Innerburden	N45E59	132'-142'	45740	0.00	25	1.61	0.02	0.42	0.048	4.0	68	9.9	3.8	-0.10	3.8	1.3
Overburden	N47E55	0'- 10'	45741	0.75	6	0.00	0.02	0.23	0.008	1.2	18	8.1	0.4	-0.10	1.0	0.2
Overburden	N47E55	10'- 20'	45742	0.00	6	0.00	0.06	0.30	0.007	1.9	26	10.1	0.4	-0.10	1.2	0.2
Overburden	N47E55	20'- 30'	45743	0.00	5	0.00	0.03	0.30	0.006	3.5	27	6.9	1.8	-0.10	2.1	0.5
Innerburden	N47E55	52'- 62'	45744	0.00	10	0.34	0.02	0.81	0.009	3.7	22	5.7	2.5	-0.10	5.2	0.4
Innerburden	N47E55	62'- 72'	45745	0.00	13	0.00	0.04	0.42	0.011	5.0	45	8.2	3.1	-0.10	3.6	1.0
Innerburden	N47E55	72'- 80'	45746	0.58	10	0.34	0.06	0.44	0.010	2.4	50	7.4	2.1	-0.10	2.6	0.7
Overburden	N47E57	0'- 10'	45747	2.19	3	0.00	0.03	0.21	0.010	2.6	34	10.5	1.2	-0.10	1.1	0.4
Overburden	N47E57	10'- 20'	45748	1.79	4	0.00	0.02	0.10	0.018	1.0	27	6.5	1.5	-0.10	1.8	0.2
Overburden	N47E57	20'- 30'	45749	2.82	6	0.00	0.05	0.12	0.017	1.4	25	5.8	1.4	-0.10	1.6	0.1
Overburden	N47E57	30'- 40'	45750	2.13	25	0.00	0.02	0.19	0.016	1.3	19	3.1	0.8	-0.10	1.1	0.1
Overburden	N47E57	40'- 50'	45751	2.53	22	0.00	0.04	0.18	0.007	6.3	28	4.8	0.6	-0.10	1.2	0.1
Overburden	N47E57	50'- 60'	45752	0.98	13	0.00	0.02	-0.01	0.016	1.5	17	3.8	0.7	-0.10	0.7	0.1
Overburden	N47E57	60'- 70'	45753	0.00	20	0.00	0.03	-0.01	0.007	3.4	22	3.4	0.7	-0.10	1.0	0.1
Overburden	N47E57	70'- 80'	45754	0.00	5	0.00	0.02	0.13	0.006	2.7	26	3.8	0.9	-0.10	1.2	0.2
Innerburden	N47E57	110'-120'	45755	0.58	20	1.68	0.02	0.12	0.003	7.8	69	23.8	4.0	-0.10	6.4	1.7
Innerburden	N47E57	120'-125'	45756	0.69	12	1.01	0.06	0.20	0.008	6.6	67	14.7	4.7	-0.10	6.3	1.5

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Sample Location	Depth	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/liter	Sodium meq/100 grams*	SAR	Texture**	Probable Sub-Surface Formation
Overburden N45 E57	30'- 40'	45719	8.2	0.70	36.0	2.96	0.11	5.42	0.20	1.63	0.06	0.80	Silt Loam	Lt. Brown Shale
Overburden N45 E57	40'- 50'	45720	8.3	0.54	31.1	1.88	0.06	4.31	0.13	2.02	0.06	1.15	Loam	Lt. Brown Sandy Shale
Overburden N45 E57	50'- 60'	45721	8.5	0.55	29.0	1.58	0.05	3.39	0.10	1.92	0.06	1.22	Sandy Loam	Lt. Brown Sandstone
Overburden N45 E57	60'- 70'	45722	8.0	1.08	33.5	4.71	0.16	6.76	0.23	3.38	0.11	1.41	Silt Loam	Lt. Brown Sandy Shale
Overburden N45 E57	70'- 80'	45723	8.0	1.19	35.0	4.38	0.15	8.06	0.28	2.84	0.10	1.14	Clay Loam	Gray Sandy Shale
Overburden N45 E57	80'- 90'	45724	8.0	2.16	23.3	9.29	0.22	12.50	0.29	5.05	0.12	1.53	Loam	Gray Sandy Shale
Innerburden N45 E57	115'-120'	45725	6.8	4.21	31.7	40.50	1.28	22.50	0.71	13.29	0.42	2.37	Silt Loam	Dark Gray Shale
Innerburden N45 E57	120'-216'	45726	6.8	4.54	36.9	47.50	1.75	25.20	0.93	12.24	0.45	2.03	Silty Clay Loam	Gray Shale
Overburden N45 E59	0'- 10'	45727	8.4	5.40	45.0	31.70	1.43	43.30	1.95	14.04	0.63	2.29	Clay Loam	Lt. Brown Topsoil
Overburden N45 E59	10'- 20'	45728	8.5	5.40	53.1	30.50	1.62	42.10	2.24	18.60	0.99	3.09	Silty Clay Loam	Lt. Brown Shale
Overburden N45 E59	20'- 30'	45729	8.3	2.43	57.5	8.13	0.47	15.49	0.89	6.66	0.38	1.94	Clay	Lt. Brown Shale
Overburden N45 E59	30'- 40'	45730	8.2	4.00	46.9	24.80	1.16	25.60	1.20	6.95	0.33	1.38	Silty Clay Loam	Lt. Brown Shale
Overburden N45 E59	40'- 50'	45731	8.3	2.81	33.3	9.05	0.30	18.90	0.63	7.15	0.24	1.91	Silt Loam	Lt. Brown Shale
Overburden N45 E59	50'- 55'	45732	8.2	2.70	41.4	6.34	0.26	17.90	0.74	6.32	0.26	1.82	Silty Clay Loam	Gray Shale

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WESTERN ENERGY COMPANY
COLSTRIP, MONTANA

All in Parts Per Million
(-) Indicates Less Than Given Value

Sample Location		Depth	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
Overburden	N45E55	0'- 10'	45704	0.86	5	1.31	0.04	0.31	0.008	48.0	17	9.6	0.9	-0.10	1.0	0.3
Overburden	N45E55	10'- 20'	45705	0.29	5	2.04	0.03	0.32	0.008	5.4	41	11.7	0.8	-0.10	1.7	0.3
Overburden	N45E55	20'- 30'	45706	0.35	12	1.61	0.04	0.24	0.010	117.0	18	22.0	0.9	-0.10	2.5	0.2
Overburden	N45E55	30'- 40'	45707	0.00	24	1.51	0.04	0.23	0.007	3.3	52	7.0	2.0	-0.10	4.1	1.2
Overburden	N45E55	40'- 50'	45708	0.00	18	1.74	0.06	0.12	0.005	4.2	104	7.1	1.6	-0.10	4.3	1.7
Overburden	N45E55	50'- 60'	45709	0.00	18	1.91	0.02	0.36	0.003	2.4	77	5.6	1.8	-0.10	5.6	1.6
Overburden	N45E55	60'- 70'	45710	0.00	15	2.35	-0.01	0.28	0.009	36.6	101	5.0	3.4	-0.10	4.9	3.3
Overburden	N45E55	70'- 80'	45711	0.00	25	2.08	0.06	0.31	0.010	25.5	72	4.6	1.1	-0.10	3.4	1.4
Overburden	N45E55	80'- 90'	45712	0.00	17	2.95	0.11	0.27	0.006	14.2	67	4.5	2.8	-0.10	8.5	2.4
Innerburden	N45E55	112'-120'	45713	0.00	40	3.95	0.03	0.50	0.005	3.9	35	2.3	1.9	-0.10	6.6	1.4
Innerburden	N45E55	120'-130'	45714	0.63	40	1.27	-0.01	0.30	0.003	27.1	71	7.4	2.6	-0.10	6.2	1.8
Innerburden	N45E55	130'-136'	45715	0.40	46	2.04	-0.01	0.31	0.010	5.2	74	7.1	1.9	=0.10	4.4	1.0
Overburden	N45E57	0'- 10'	45716	0.63	4	1.57	-0.01	0.42	0.010	1.3	17	6.5	0.9	-0.10	0.9	0.2
Overburden	N45E57	10'- 20'	45717	0.00	7	0.67	-0.01	0.22	0.011	1.0	20	4.8	2.1	-0.10	3.3	0.2
Overburden	N45E57	20'- 30'	45718	0.58	16	1.34	0.02	0.13	0.009	44.3	22	11.9	1.2	-0.10	2.1	0.2
Overburden	N45E57	30'- 40'	45719	0.92	9	1.41	0.01	0.20	0.008	9.3	27	7.6	1.4	-0.10	1.4	0.3
Overburden	N45E57	40'- 50'	45720	0.58	4	1.01	0.02	0.19	0.010	3.4	25	7.4	0.6	-0.10	1.2	0.2
Overburden	N45E57	50'- 60'	45721	0.58	30	0.74	0.02	0.22	0.011	1.0	17	5.1	0.2	-0.10	0.9	0.1
Overburden	N45E57	60'- 70'	45722	0.00	27	1.68	0.02	0.23	0.008	33.7	40	11.8	1.2	-0.10	1.2	0.4
Overburden	N45E57	70'- 80'	45723	0.00	32	0.94	0.01	0.17	0.010	8.1	63	10.9	2.4	-0.10	2.4	0.8
Overburden	N45E57	80'- 90'	45724	0.58	11	1.01	0.02	0.18	0.011	17.0	89	9.7	2.8	-0.10	2.4	0.8
Innerburden	N45E57	115'-120'	45725	0.58	23	5.36	0.01	0.63	0.012	40.8	61	11.8	2.9	0.12	3.4	1.8
Innerburden	N45E57	120'-126'	45726	0.58	36	4.02	0.02	0.31	0.013	11.3	42	16.9	2.6	-0.10	4.6	1.5
Overburden	N45E59	0'- 10'	45727	0.58	31	1.84	0.02	0.20	0.019	1.1	20	7.0	0.9	-0.10	1.5	0.3
Overburden	N45E59	10'- 20'	45728	0.00	21	1.81	0.02	0.18	0.018	1.2	16	4.7	0.9	-0.10	1.6	0.3
Overburden	N45E59	20'- 30'	45729	0.75	12	1.27	0.02	0.15	0.017	3.1	38	5.3	1.4	-0.10	2.5	0.2
Overburden	N45E59	30'- 40'	45730	0.98	6	1.68	0.02	0.13	0.018	1.7	26	4.4	1.4	-0.10	2.0	0.1
Overburden	N45E59	40'- 50'	45731	0.40	4	2.04	0.02	0.10	0.011	1.8	19	4.2	1.1	-0.10	1.3	0.3

APPENDIX D

Well and Spring Data for the Vicinity of Colstrip, Montana

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (µmhos/cm)	Water temperature (°C)	Water use	Water source
3N39E 36BACD	235	72.2	3130	7-73	1400	13.5	S	SubMc
3N42E 34DBBC	330	36.3	3020	10-73			S	SubMc
2N39E 03CDBB	113	61	3190	9-73			S	SubMc
2N39E 05BCBA			3210	9-73	2400	11.0	S	SubMc
2N39E 05DDDC		15.2	3170	9-73	6638L	13.3	S	SubMc
2N39E 10BBCA	130	75	3250				S	SubMc
2N39E 12CCC1	555		3160		1200	13.5	H	Tullock
2N39E 12CCC2	71	35	3150				S	SubMc
2N39E 12CCDB	20	17	3130				S	Alluvium
2N39E 16ACDD	100	35	3260				S	SubMc
2N39E 23CAAB		98.7	3360	7-73	1450	27.0	S	SubMc
2N39E 24CDAB	140	50	3250	7-73	3030L		S	SubMc
2N39E 24CDDD	46	18.1	3240	7-73			U	SubMc
2N39E 25ACDC	136	58	3280	7-73	5060L		S	SubMc
2N39E 27CCCC	262	127.6	3430	7-73			S	SubMc
2N39E 32DDDD			3520	7-73	3500	12.5	S	RO
2N39E 34ADBB	60	27	3435	72	2940L		H	SubMc
2N39E 34DADB	80	26.9	3470	7-73	2050L	16.0	S	SubMc
2N40E 04BBAA	84	30	3280				S	SubMc
2N40E 06ABAA	86	70	3190				S	SubMc
2N40E 06ABAB	40	40	3190				H	SubMc
2N40E 06ABAC	143	84	3190				S	SubMc

EXPLANATION

Depth to water: Whole numbers only--reported; whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L; laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table I. - Well data for the Colstrip vicinity; data collected by U.S. Geological Survey and Montana Bureau of Mines & Geology.

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (µmhos/cm)	Water temperature (°C)	Water use	Water source
2N40E06CBCB	104	84	3170		3000	10.5	S	SubMc
2N40E07BCDB	128	80	3210	7-73			S	SubMc
2N40E10BBCD	210	145	3280				S	SubMc
2N40E11AABA	130	60	3240				S	SubMc
2N40E12AAAB	165	30	3260				H	SubMc
2N40E17ABDD	185	80	3480				S	SubMc
2N40E17AACA	184	165	3440				S	SubMc
2N40E24CDCD	80	60	3250				S	SubMc
2N40E24DCBA	30	22	3220				S	Alluvium
2N40E24DBDC	85	60	3220				H	SubMc
2N40E29CCDC			3380				S	SubMc
2N40E30BAAC	246	72	3270	7-73	3500	14.0	S	SubMc
2N40E31DCCD	165	113.6	3530	11-72	1750	13.0	S	SubMc
2N40E32BBAB			3390	7-73	950		H	SubMc
2N40E32BBDA	67	23.3	3430	7-73			U	RCl
2N40E33ADDD	140	100	3360				S	SubMc
2N40E35DDCD	250	148.2	3425	7-73	2800	11.5	S	SubMc
2N41E01DBBA		61.7	3150	8-73	878L	11.5	S	SubMc
2N41E02DBBA	220		3170		3290L		H	SubMc
2N41E02DBBB	10	3	3210				S	SubMc
2N41E06BBBB	165	45	3140				S	Tullock
2N41E06BBBB	121	30	3140				S	Tullock
2N41E08ACCD			3182				S	SubMc

EXPLANATION

Depth to water: Whole numbers only--reported: whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L: laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 1. - (continued)

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (µmhos/cm)	Water temperature (°C)	Water use	Water source
2N41E10BCBC	150	100	3170		1825	13.0	S	SubMc
2N41E17ADAA	110		3121	10-73	2398L	12.0	H	SubMc
2N41E21CADA	122	29.7	3185	11-72	3350L	10.0	P	SubMc
2N41E22BAAB	68	57	3260				S	SubMc
2N41E24CAA1	18		3450				H	RO
2N41E24CAA2	27	23.6	3450	7-73			S	RO
2N41E30DDAA			3360	10-73	3076L	13.0	S	RCl
2N41E32DABB	300	140	3420				S	SubMc
2N41E33DAAD	1520	60	3270				P	Hell Creek ✓
2N41E33DAAD	596		3270				P	Tullock
2N42E33DAAA	529	315	3270				P	Tullock
2N41E34BADC	9336		3210				P	Madison ✓
2N41E34BCBB	614		3220				P	Tullock
2N42E04DACA	102	60	3010		2058L	11.5	S	SubMc
2N42E05CABB		56.5	3070	11-72	2072L	11.0	S	SubMc
2N42E06CBDC	120	87.3	3140	11-72	1850	12.0	S	SubMc
2N42E20CDAD			3200				S	SubMc
2N42E30CDCB	200		3240				S	SubMc
2N42E32DBCC	100		3130				S	SubMc
1N39E01BBBA	84	30	3460				S	SubMc
1N39E01BBBA	96	39.9	3470	7-73			S	SubMc
1N39E05CBB1	300		3685		3000	12.0	S	RO

EXPLANATION

Depth to water: Whole numbers only--reported; whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L; laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 1. - (continued)

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (µmhos/cm)	Water temperature (°C)	Water use	Water source
1N39E19CAAB			3795	10-73	3582L	9.0	S	RO
1N39E24BBBC		62	3826	9-73	2423L	12.0	S	RO
1N39E26ABBB	375		3978				S	RO
1N39E30BCAC			3630	10-73	5258L	13.0	H	RO
1N39E31AAAC			3779	7-73	2100L	10.5	S	RO
1N40E01CCCD	80	34.1	3418	7-73			S	McC
1N40E02BBDC	44	34.1	3510	7-73	520	9.0	H	RO
1N40E02CDCC	100	42.2	3512	10-73	1258L	11.0	S	RC
1N40E04CAAA	200	75	3440				S	SubMc
1N40E04DADA			3505				S	
1N40E05CCCB	115	85.3	3530				S	McC or SubMc
1N40E06ABBB	128	40	3520				S	SubMc
1N40E07BCBB	143	84.3	3723				S	RO
1N40E10DAAB	132	50	3470				S	McC
1N40E11ABBB			3558				S	
1N40E12CBAA	40	35.4	3400	9-73	1700	10.5	S	Alluvium
1N40E12DCCD			3427	10-73	2298L	11.0	S	
1N40E14BBBB1			3438	10-73	1542L	10.0	S	
1N40E14BBBB2			3438	10-73	1344L		H	
1N40E16AADA			3480	9-73	1520L	11.0	S	
1N40E16DBAA		42.8	3520	9-73			U	
1N40E18ABBB			3640				H	
1N40E18DDCD	50	23	3654	9-73			U	RO

EXPLANATION

Depth to water: Whole numbers only--reported; whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L; laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 1. - (continued)

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (µmhos/cm)	Water temperature (°C)	Water use	Water source
1N40E21AAAD	120	106.4	3548				U	RC
1N40E23BDDB	100	30	3420				S	RC
1N40E24CACB	66	35.3	3390	9-73			S	RO
1N40E28ADDD	74	35.4	3410	9-73			S	RO
1N40E29ABCD	232	80	3555		2756L	10.5	S	RC
1N40E36BACD	104	85	3448	9-73			S	RO
1N41E02DB	141	75	3330				S	RC & McC
1N41E03BBBB	55	45	3240				S	McC
1N41E03CDDD	86	67.4	3330	8-73	1600	11.5	S	RO
1N41E06DDDB			3362				S	
1N41E07DBBA	125	100	3360	10-73	1160L	11.0	S	SubMc
1N41E08BBDC	389		3320					SubMc
1N41E08BBDB	50		3320		2610L	13.0	H	Alluvium
1N41E08BBDD	50		3320					Alluvium
1N41E08CBAB	118	22.1	3357	10-73	869L	9.0	S	RC
1N41E06CBAB	18		3355	10-73	776	11.0	U	RO
1N41E12CBDB			3370	8-73	3000	15.5	S	
1N41E13CDCD	200	108.9	3290	11-72	2150	16.0	I	SubMc
1N41E23BCDC	74	44.9	3230	6-73	2594L	19.0	N	SubMc
1N41E23CB	80	65	3220				N	SubMc
1N41E23CC	300	190	3240				H	SubMc
1N41E23	60	44					N	SubMc
1N41E24DDBB		13.8	3150	8-73			S	SubMc

EXPLANATION

Depth to water: Whole numbers only--reported; whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L: laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 1. - (continued)

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (µmhos/cm)	Water temperature (°C)	Water use	Water source
1N41E25DDBB		38.3	3090	8-73			S	SubMc
1N41E26BCAB	195	23.5	3190	8-73			U	SubMc
1N41E30BBCD	90	30	3330				S	RC
1N41E31AADA	153	38.3	3250	9-73			S	SubMc
1N41E33BCCB	65	22	3190	9-73			S	SubMc
1N42E07CBBD	940		3260				F	Hell Creek
1N42E10CCDC	43	10.3	3075	10-72	3100	10.5	S	SubMc
1N42E12ABBA	42		2956				S	SubMc
1N42E13BCAC			3090				U	
1N42E19DBBA	67	22.7	3130	8-73	1600	11.0	S	McC
1N42E22CABD	55		3050	9-73	4696L	11 0	S	SubMc
1N42E25BBCC	107		2950				S	SubMc
1N42E25BCDD	94	7.5	2930	9-73	4000		H	SubMc
1N42E28BDDC	53	17.8	2990	8-73	1906L	10.0	S	SubMc
1N42E31BBBC			3090				S	
1N42E32DADD	80	33.7	2990	8-73			S	SubMc
1N42E33ADBC	42	24.2	2970	9-72	3200	10.0	S	SubMc
1N42E33BDDB	91	57	2990				S	SubMc
1N42E34ACAB	275	1.4	2960	1-73	2420L		H	SubMc
1S39E04BCAC		100	3591	7-73			S	RO
1S39E04BCAC			3591				S	RO
1S39E07CABA		90	3640	7-72			S	RC

EXPLANATION

Depth to water: Whole numbers only--reported: whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps: accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L: laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 1. - (continued)

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (µmhos/cm)	Water temperature (°C)	Water use	Water source
1S39E07DBBB	215	65	3620				S	RC
1S39E08BBDB			3598				S	
1S39E08BCBD			3608				S	
1S39E09CDBD	220		3729				S	RO
1S39E18BDAA	109		3665				H	RC
1S39E20DBCB	250	60	3760				S	RO
1S40E05CDAD			3670	9-73			S	RO
1S40E06DAAD	150	120	3757	9-73			S	RO
1S40E07DADA	420	220	3580	7-73	2906L	13.0	S	RC
1S40E09DADB	44	41.5	3490	7-73			S	RO
1S40E14DCBD	62	50.4	3327	9-73			S	RO
1S40E16DABD	65	60	3410	7-73			S	RO
1S40E25ABDB		35.7	3270				S	
1S40E29DBAC		100					P	
1S40E31ADDD		110	3520				P	
1S40E32DBBB			3540				P	
1S41E01DBAA	54	38	3110	9-73			S	SubMc
1S41E02AABB	81	26.5	3050	7-73	2948L		S	SubMc
1S41E05CDAB	150	105	3220				S	SubMc
1S41E13ACCB	60	14	3060				S	SubMc
1S41E13BDDD	80	14	3060				H	SubMc
1S41E14CCCB	70	26.5	3050	7-73			S	SubMc
1S41E15DDCA	71		3091				S	SubMc

EXPLANATION

Depth to water: Whole numbers only--reported; whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L: laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 1. - (continued)

Well location	Well depth (feet)	Depth to water (feet)	Land-surface altitude (feet)	Date examined	Specific conductance of water (μmhos/cm)	Water temperature (°C)	Water use	Water source
1S41E17DAAA	45	24	3169		2450	10.5	S	SubMc
1S41E23BABC	60	22.2	3070	7-73			S	
1S41E23BACB	248		3070				H	

EXPLANATION

Depth to water: Whole numbers only--reported; whole numbers and tenths--measured.
Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L: laboratory).
Water use: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public; S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud Clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 1. - (continued)

Location	Land-surface altitude (feet)	Water temperature (° C)	Date examined	Specific conductance of water (µmhos/cm)	Flow	Water use	Water source
3N39E30BCBA	3310					S	SubMc
3N39E33DCCC	3115					S	SubMc
3N39E34CCBC	3095					S	SubMc
3N41E34CCCD	3200	12.0	11-72	380	0.2	S	SubMc
2N39E07BDCB	3280					S	SubMc
2N39E08CBAD	3230					S	SubMc
2N39E18ABDC	3300					S	SubMc
2N39E10DBDA	3335					S	SubMc
2N39E24BDA	3210					S	SubMc
2N39E31ABAA	3500	12.0	10-72	3550	8	S	RC
2N39E31CBCD	3620					S	RO
2N39E31CDCC	3620					S	RO
2N39E31CDCD	3620					S	RO
2N39E36CDDB	3400		7-73		0.5	S	McC
2N40E18DB		13.0	10-72	3550	3.2	S	SubMc
2N41E17ADAD	3120	14.0	10-73	2798L		S	SubMc
1N39E06ADDA	3685					S	RO
1N39E08CDDA	4153						RO
1N39E09DDAA	3910					S	RO
1N39E14BBAB	3820		10-73			S	RO

EXPLANATION

Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps: accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L: laboratory).
Flow: Estimated spring discharge (gallons per minute).
Water use: S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud clinker; RC, Rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 2. - Spring data for the Colstrip vicinity; data collected by U.S. Geological Survey and Montana Bureau of Mines & Geology.

Location	Land-surface altitude (feet)	Water temperature (°C)	Date examined	Specific conductance of water (µmhos/cm)	Flow	Water use	Water source
1N39E17AACB	4255					S	RO
1N39E18ADCC	4180					S	RO
1N39E18ADDD	4320					S	RO
1N39E18BDCB	3998		8-73		2	S	RO
1N39E19CAAB	3790		10-73			S	RO
1N39E21BBCD	4180					S	RO
1N39E22BBBA	4010					S	RO
1N39E22DDDC	3999	10.5	10-73	2140L	5	S	RO
1N39E23CCBB	3990		10-73		1	S	RO
1N39E24ABCC	3785		10-73		1	S	RO
1N39E29CBAB	3735						RO
1N39E30BCAD	3605		10-73		0.5	S	RO
1N39E32BADA	3740						RO
1N40E02BABD	3440	17.0	7-73	2930L	0.6	S	RC
1N40E02BBDD	3450		7-73			S	RC
1N40E02BDAB	3450		7-73			S	RC
1N40E19DCCD	3625	11.5	9-73	2090L	1	S	RO
1N40E20DADC	3512		9-73		0.3	S	RO
1N40E30ABB	3610		9-73		3	S	RO
1N40E30DABB	3610		9-73		3	S	RO
1N40E31DBDA	3610		7-73		1	S	RO
1N41E24CCAA	3130					S	McC

EXPLANATION

Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps; accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L; laboratory).
Flow: Estimated spring discharge (gallons per minute).
Water use: S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud clinker; RC, rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 2. - (continued)

Location	Land-surface altitude (feet)	Water temperature (° C)	Date examined	Specific conductance of water (umhos/cm)	Flow	Water use	Water source
1N41E27BAAA	3240		10-73		1	U	RC
1S39E02BCBB	3952					S	RO
1S39E03BACD	3849					S	RO
1S39E10DCBB	3872					S	RO
1S39E12DCBA	3770	13.0	9-73	1900	1	S	RO
1S39E16BCAC	3804					S	RO
1S39E16DABB	3810					S	RO
1S40E06BBDB	3890	11.0	9-73	1640	0.2	S	RO
1S40E07CBCD	3670				0.2	S	RO
1S40E08AAAC	3600	12.5	9-73	2400	2	S	RO
1S40E12DDD		14.0	7-73	692L	0.5	S	RO

EXPLANATION

Land-surface altitude: Estimated from U.S. Geol. Survey 7½ min. topog. maps: accurate to 10 feet.
Specific conductance: Field measurements unless otherwise noted (L; laboratory).
Flow: Estimated spring discharge (gallons per minute).
Water use: S, stock; U, unused.
Water source: Coded sources--RO, Rosebud overburden; RCl, Rosebud clinker; RC, rosebud coal; McC, McKay coal; SubMc, unspecified aquifers below strippable interval.

Table 2. - (continued)

Location	Type	Use	Source	Probable Hydrologic Effect During Mining	Principal Effecting Area
2N41E30DDAA	W	S	RO	Moderate WL decline	A
1N40E05CCCB	W	S	McCorSubMc	Moderate WL decline	C
1N40E12CBAA	W	S	A1	Severe WL decline	C
1N40E20DADC	S	S	RO	Slight yield decrease	C
1N40E21AAAD	W	U	RC	Severe WL decline	C
1N40E23BDDB	W	S	RC	Moderate WL decline	C
1N40E24CACB	W	S	RO	Moderate WL decline	C
1N40E28ADDD	W	S	RO	Slight WL decline	C
1N40E29ABCD	W	S	RC	Slight WL decline	C
1N41E08BBDB	W	H	A1	Severe WL decline	B
1N41E08BBDD	W	-	A1	Severe WL decline	B
1N41E12CBDB	W	S	Unknown	Unknown	-
1N41E24CCAA	S	S	McC	Moderate yield decrease	B
1N41E27BAAA	S	U	RC	Moderate yield decrease	B
1N41E30BBCD	W	S	RC	Moderate WL decline	B
1N42E19DBBA	W	W	McC	Slight WL decline	D

[illegible] OF MINES

EXPLANATION

Type

W: Well
S: Spring

Use

S: Stock
H: Domestic
U: Unused
-: Unknown

Source

RO: Rosebud Overburden
RC: Rosebud Coal
RCl: Rosebud Clinker
McC: McKay Coal
SubMc: Sub-McKay Aquifers

Probable Hydrologic Effect During Mining

Severe: Possible loss for use
Moderate: Possible seasonal loss for use
Slight: Minimal seasonal decrease for use

Principal Effecting Area

A: Probable Mine Area "A"
B: Probable Mine Area "B"
C: Probable Mine Area "C"
D: Probable Mine Area "D"
E: Probable Mine Area "E"

Table 4. - Predicted hydrologic effects of mining on wells and springs near Colstrip.

APPENDIX E

Plant Community Descriptions, Area B Colstrip, Montana

Plant Community Descriptions:

Taken from: Ecological Consulting Service 1975. Western Energy Vegetation. Production, Condition and Community Typing. Mining areas A, B and E. Project 107.23.A. Helena, Montana. 38 pp.

Grassland Communities:

Agropyron smithii-Bromus spp.-Poa. spp. (111.1)

This community was present on mesic bottomlands of heavy soils. The SCS range site for this type was classed as overflow (USDA 1971), which is characterized by low mesic bottomland.

Dominant grass species in this community were western wheatgrass (Agropyron smithii), Japanese chess (Bromus japonicus), Kentucky bluegrass (Poa pratensis), and green needlegrass (Stipa viridula). The type was similar to Plant Community 220.

Agropyron smithii-Koeleria cristata-Carex filifolia (111.2)

This plant community occurred adjacent to the community previously discussed but at slightly higher elevations. Gradients were not much different as it usually was found on low benches, but sites were slightly more xeric than at sites occupied by Plant Community 111.1. At times it appeared to be an ecotone between Plant Communities 111.1 and 111.3

Dominant grass species found in this community were western wheatgrass, Japanese chess, junegrass (Koeleria cristata), green needlegrass, cheatgrass (Bromus tectorum), and threadleaf sedge (Carex filifolia). Western wheatgrass was found at all sites. Green needlegrass occurred in transects conducted closest to Plant Community 111.1. Junegrass and blue grama were found in transects in closer proximity to Plant Community 111.3

Stipa comata-Carex filifolia-Koeleria cristata (111.3)

Upper benches, knolls, and ridges not dominated by shrubs or timber were sites where this plant community occurred. This was a common plant community and was rather widespread in the areas of study. Sindelar (1972) described a similar range type. This community would probably be more extensive if not for past disturbance. It generally occurred at gradients above that of Plant Community 111.2 in more xeric soils.

The three most common grasses were needle-and-thread (Stipa comata), threadleaf sedge, and junegrass. Needle-and-thread was found in every transect. Japanese chess, cheatgrass, and red three-awn (Aristida longiseta) were also found in this plant community.

Calamovilfa longifolia-Andropogon spp. (111.4)

This community occurred as localized patches on knolls and on footslopes of ridges. It was generally found in close association with sandy soils and appeared to occur on any exposure near the top of knolls or ridges.

Prairie sand reedgrass (Calamovilfa longifolia) and little bluestem (Andropogon scoparius) were dominant grasses. Big bluestem (Andropogon gerardii) occurred at some sites along with junegrass and needle-and-thread. Some sites tended to be dominated more by little bluestem and others by prairie sand reedgrass.

Bromus tectorum (111.5)

This community occurred as isolated sites wherever the other natural types were disturbed or severely overgrazed. It occurred more often in Plant Communities 111.2 and 111.3 as well as in shrub-grassland communities such as Plant Community 213. It was often found on south-facing slopes that "green up" early in the spring and hence are sought out and overgrazed by livestock. It also occurred near windmills where livestock gather for water. It could occur in any natural plant community. It was characterized by dense stands of cheatgrass.

Shrub-grassland Communities:

Artemisia tridentata-Koeleria cristata-Agropyron spicatum (211)

Upper slopes and benches were common sites where this plant community was found. Soils of this community were fine and clayey. Often times this plant community appeared to be overgrazed.

Big sagebrush (Artemisia tridentata) was the dominant shrub and appeared to be very scrubby. Common grasses were junegrass, which appeared in every transect, and bluebunch wheatgrass (Agropyron spicatum). Western wheatgrass, Japanese chess, blue grama, and sandberg bluegrass (Poa secunda) were other common grasses.

Artemisia cana-Agropyron smithii-Stipi viridula-Poa spp. (212.1)

This plant community characteristically occupied the moist drainage channels in the areas of study and was typically associated with the moist, coarser soils of alluvial overflow sites (Parker 1970). It was generally found in mesic draws and coulees. Sindelar (1972) described a similar range type. It was usually bordered by Plant Communities 111.1 or 212.2.

Silver sagebrush was the dominant shrub and occurred in very dense stands. Common grasses were western wheatgrass, green needlegrass, and bluegrasses (Poa spp.). At times, Japanese chess occurred also.

Artemisia cana-Agropyron smithii-Stipi viridula-Bromus spp. (212.2)

This plant community was found on lower benches adjacent to swales and coulees inhabited by Plant Community 212.1. The SCS range site classification was silty compared to overflow for Plant Community 212.1 (USDA 1971). The dominant shrub in this community was silver sagebrush, but was found in sparse stands in comparison to the dense stands in

Plant Community 212.1. Grasses indigenous to this type were similar to Plant Community 212.1 and consisted of western wheatgrass, green needlegrass, cheatgrass, and Japanese chess.

Rhus trilobata-Stipa comata-Agropyron smithii (213)

This plant community occurred often near and within stands of ponderosa pine (Pinus ponderosa) (Martin 1973). At other sites it was found as a distinct shrub-grassland community with no close association with stands of ponderosa pine. It was found in sandy soils on ridges, knolls, or south-facing slopes. Other sites where this community was found was near sandstone outcrops or on flat benches surrounded by ponderosa pine. Since it was often found on south-facing slopes, cheatgrass was quite common at these sites, again due to the early "green up" and associated overgrazing by livestock.

Skunkbush sumac (Rhus trilobata) was the most dominant shrub. Common grasses were western wheatgrass, needle-and-thread, junegrass, prairie sand reedgrass, bluebunch wheatgrass, and cheatgrass.

Chrysothamnus nauseosus-Agropyron spicatum-Oryzopsis hymenoides (214)

This community generally occurred on isolated knobs and knolls in conjunction with unstable clay gumbos. It also occurred on very steep gumbo slopes. This type was not very extensive in size but could be found throughout the areas of study. The SCS range site was determined to be a dense clay site (USDA 1971). Vegetation was very sparse.

Rubber rabbitbrush (Chrysothamnus nauseosus) was the most common shrub. Other shrubs that occurred in this type was shadscale saltbush (Atriplex confertifolia), broom snakeweed, and big sagebrush. Bluebunch wheatgrass and Indian ricegrass (Oryzopsis hymenoides) were the two most common grasses. Western wheatgrass was also found at some sites.

Timber-grassland Communities:

Acer negundo-Fraxinus pennsylvanica-Poa spp.-Agropyron smithii (220)

This plant community occurred along creek bottoms. The major creek in the area of study was the upper east fork of Armell's Creek. The overstory consisted of box elder (Acer negundo) and green ash (Fraxinus pennsylvanica). A few plains cottonwoods (Populus deltoides) could also be found. The understory of this community was very similar to Plant Community 111.1. Common grasses consisted of Kentucky bluegrass and western wheatgrass. At other sites, shrubs such as prairie rose (Rosa arkansana) and snowberry (Symphoricarpos spp.) occurred in the understory. This type was limited in extent in the area of study, and most of it had been disturbed by the extensive construction of new mining facilities that border the east fork of Armell's Creek.

Pinus ponderosa-Agropyron spicatum (351)

This plant community occurred at higher elevations along ridges and sandstone outcrops within the study area. At some sites this community occurred along coulees leading away from the ridges. The soils were classed as thin-hilly by SCS criteria (USDA 1971). The overstory aspect of the type varied from a near closed canopy "woods" to a very open canopy "savanna" of scattered trees. The understory varied inversely with the overhead canopy in regard to cover. In areas of open canopy the understory was well developed, and in areas of closed canopy the understory was generally sparse and poorly developed.

Kuchler (1964) described the entire Colstrip vicinity as an eastern ponderosa pine vegetation formation. Pfister, et al. (1973) described the area as a Pinus ponderosa/Agropyron spicatum habitat type within a Pinus ponderosa series.

Ponderosa pine was the most common tree. Rocky Mountain juniper (_Juniperus scopulorum_) occurred in limited fashion. Common grasses consisted of bluebunch wheatgrass, threadleaf sedge, needle-and-thread, and junegrass. Skunkbush sumac was a common shrub.

Pinus ponderosa-Juniperus scopulorum-Agropyron spicatum (352)

This community occurred on ridges at high elevations. It was very limited in extent in the areas of study and was usually found on steep north-facing slopes.

Rocky Mountain juniper was the most common tree. Ponderosa pine occurred in limited fashion. Like Plant Community 351, the understory varied from barren areas to quite shrubby areas inversely dependent on the overstory canopy. This plant community was generally more open in regard to overstory canopy than Plant Community 351. The most common grass was bluebunch wheatgrass. Other grass species included Japanese chess, sideoats grama (_Bouteloua curtipendula_), and plains _muhly_ (_Muhlenbergia_ cuspidata). Common shrubs were big sagebrush, skunkbush sumac, and rubber rabbitbrush.

Non-natural Plant Communities:

Agricultural (530)

Sites disturbed by man for agricultural purposes, such as fields of winter wheat, its associated fallow and alfalfa, were classed as agricultural plant communities.

Stock Ponds (543)

These sites consisted of stock watering ponds created by the damming of drainages for the purpose of providing water for domestic livestock.

Disturbed Grassland (651)

This plant community occurred wherever man disturbed the natural plant communities in the past by plowing. These sites varied in grass species present due to the successional response over the number of years since disturbance. Recent sites were dominated by crested wheatgrass (Agropyron cristatum). Native grasses such as western wheatgrass and needle-and-thread occurred on apparently older sites. Invading annuals such as cheatgrass and Japanese chess were also found at these sites.

Roadways (652)

This type consisted of county roads, highways, railroads, and their associated borrow areas.

Residential Areas (653)

These sites were very limited in extent and consisted of farm and ranch yards, corrals and other disturbed areas used to park farm equipment.

APPENDIX F

List of Animals Observed in the Vicinity of Colstrip, Montana

APPENDIX F - List of animals observed in the vicinity of Colstrip

	Scientific Name	Common Name
MAMMALS:	*Antilocapra americana*	Pronghorn antelope
	Canis latrans	Coyote
	Cynomys ludovicianus	Black-tailed prairie dog
	Erethizon dorsatum	Porcupine
	Eutamias minimus	Least chipmunk
	Lepus townsendii	White-tailed jackrabbit
	Lynx rufus	Bobcat
	Marmota flaviventris	Yellow-bellied marmot
	Mephitis mephitis	Striped skunk
	Microtus ochrogaster	Prairie vole
	Mus musculus	House mouse
	Mustela frenata	Longtail weasel
	Myotis lucifugus	Little brown bat
	Odocoileus hemionus	Mule deer
	Odocoileus virginianus	White-tailed deer
	Ondatra zibethicus	Muskrat
	Peromyscus maniculatus	Western deer mouse
	Procyon lotor	Raccoon
	Sorex cinereus	Masked shrew
	Spermophilus tridecemlineatus	Thirteen-lined ground squirrel
	Sylvilagus audubonii	Desert cottontail
	Taxidea taxus	Badger
	Thomomys talpoides	Northern pocket gopher
	Vulpes vulpes	Red fox
BIRDS:	*Actitis macularia*	Spotted sandpiper*
	Aeronautes saxatalis	White-throated swift*
	Agelaius phoeniceus	Red-winged blackbird
	Ammodramus savannarum	Grasshopper sparrow*
	Anas acuta	Pintail
	Anas cyanoptera	Cinnamon teal
	Anas discors	Blue-winged teal
	Anas platyrhynchos	Mallard
	Anas strepera	Gadwall
	Aquila chrysaëtos	Golden eagle
	Ardea herodias	Great blue heron
	Asio flammeus	Short-eared owl*
	Bartramia longicauda	Upland plover
	Branta canadensis	Canada goose
	Bubo virginianus	Great horned owl
	Buteo jamaicensis	Red-tailed hawk

(Continued)

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*Denotes Audubon Society observations along Colstrip-Brandenberg route (Roney and Phelps (1968-1974).

APPENDIX F - Continued

	Scientific Name	Common Name
BIRDS: (Continued)	*Calamospiza melanocorys*	Lark bunting
	Capella gallinago	Common snipe*
	Centrocercus urophasianus	Sage grouse
	Charadrius vociferus	Killdeer
	Chondestes grammacus	Lark sparrow
	Chordeiles minor	Common night hawk
	Circus cyaneus	Marsh hawk
	Coccyzus americanus	Yellow-billed cuckoo*
	Colaptes cafer	Red-shafted flicker
	Contopus sordidulus	Western wood pewee*
	Corvus brachyrhynchos	Common crow
	Dendroica auduboni	Audubon warbler*
	Dendroica petechia	Yellow warbler
	Dumetella carolinensis	Catbird*
	Empidonax oberholseri	Dusky flycatcher*
	Eremophila alpestris	Horred lark
	Euphagus carolinus	Rusty blackbird
	Euphagus cyanocephalus	Brewer's blackbird
	Falco sparverius	Sparrow hawk
	Falco mexicanus	Prairie falcon*
	Fulica americana	American coot
	Geothlypis trichas	Yellowthroat*
	Gymnorhinus cyanocephala	Piñyon jay
	Haliaeetus leucocephalus	Bald eagle*
	Hirundo rustica	Barn swallow
	Icteria virens	Yellow-breasted chat*
	Icterus bullockii	Bullock's oriole*
	Lanius ludovicianus	Loggerhead shrike
	Loxia curvirostra	Red crossbill*
	Mareca americana	American widgeon
	Melanerpes erythrocephalus	Red-headed woodpecker
	Melospiza melodia	Song sparrow*
	Molothrus ater	Brown-headed cowbird
	Parus atricapillus	Black-capped chickadee
	Passer domesticus	House sparrow
	Pedioecetes phasianellus	Sharp-tailed grouse
	Perdix perdix	Hungarian partridge
	Petrochelidon pyrrhonota	Cliff swallow*
	Phasianus colchicus	Ring-necked pheasant
	Pheucticus melanocephalus	Blackheaded grossbeak*
	Pica pica	Magpie
	Pipilo erythrophthalmus	Rufous-sided towhee*
	Pooecetes gramineus	Vesper sparrow
	Quiscalus quiscula	Common grackle
	Rhynchophanes mccownii	McCown's longspur
	Riparia riparia	Bank swallow

(Continued)

	Scientific Name	Common Name
BIRDS: (Continued)	*Salpinctes obsoletus*	Rock wren*
	Sayornis saya	Say's phoebe
	Setophaga ruticilla	American redstart*
	Sialia currucoides	Mountain bluebird
	Sitta carolinensis	White-breasted nuthatch
	Spatula clypeata	Shoveller
	Spinus tristis	American goldfinch
	Spizella breweri	Brewer's sparrow
	Spizella pallida	Clay-colored sparrow*
	Spizella passerina	Chipping sparrow*
	Steganopus tricolor	Wilson's phalarope
	Stelgidopteryx ruficollis	Rough-winged swallow*
	Sturnella neglecta	Western meadowlark
	Sturnus vulgaris	Starling
	Tachycineta thalassina	Violet-green swallow
	Toxostoma rufum	Brown thrasher
	Troglodytes aedon	House wren
	Turdus migratorius	Robin
	Tyrannus tyrannus	Eastern kingbird
	Tyrannus verticalis	Western kingbird
	Vireo olivaceus	Red-eyed vireo*
	Zenaidura macroura	Mourning dove
	Zonotrichia leucophrys	White-crowned sparrow
REPTILES:	*Chelydra serpentina*	Common snapping turtle
	Chrysemys picta	Western painted turtle
	Coluber constrictor	Racer
	Crotalus viridis	Prairie rattlesnake
	Heterodon nasicus	Hognose snake
	Pituophis catenifer	Bull snake
AMPHIBIANS:	*Rana pipiens*	Leopard frog

Reference: Ecological Consulting Service 1975, the Montana Power Company, Colstrip, 10 x 20 Area Wildlife and Wildlife Habitat Annual Monitoring Report, Helena, Montana.

APPENDIX G

Grain Production Data for Mining Area B, Colstrip, Montana

BURLINGTON NORTHERN

RESOURCES DEVELOPMENT
DEPARTMENT

P. O. Box 579
Miles City, Montana 59301
Telephone (406) 232 1274

Joann Vorovilchuk
Dept. of State Lands
Capitol Station
Helena, Mt. 59601

March 17, 1976

Dear Madam:

In regard to your telephone request for production information for Sections 3 & 10-1N-41E, the following information is submitted.

Acreage under cultivation in Section 3 amounts to 150.5 acres and 129.1 acres in Section 10.

James W. Snider is the lessee on the above lands and on parts of 2 other nearby sections for which the production figures are based on.

Year	Crop	Bu./ac. Average	
1974	W. wheat	36.4	
	S. wheat	8.0	
1973	W. wheat	37.2	
1972	W. wheat	32.5	
1971	W. wheat	19.9	(hail damage)
1970	W. wheat	38.3	
	Oats	41.0	

Sincerely,

R. J. Goroski

R. J. Goroski
Suprv. Rangelands

RJG/th

APPENDIX H

Montana Fish and Game Department Memorandums Describing Colstrip Area Game Violations

DEPARTMENT OF FISH AND GAME
HELENA, MONTANA

Office Memorandum

TO : Wesley Woodgerd, Director
Attn: Jim Posewitz

DATE: 1-26-76

FROM : Keith G. Seaburg, Reg. Coord.
By: Bill Maloit

SUBJECT: Wildlife Law Enforcement - Colstrip and Sarpy Area

Enclosed are specific reports from Wardens Bivins and Heck regarding the impact of the coal industry on wildlife law enforcement in Rosebud and Treasure Counties.

The impact cannot be given a complete evaluation as we do not have personnel or funds to provide the patrols to prevent violations and gain reasonable compliance to laws and regulations.

KGS:BM:fr

cc: O.W. Lewis

DEPARTMENT OF FISH AND GAME

HELENA, MONTANA

Office Memorandum

TO :

DATE: January 23, 1976

FROM : Thomas E. Bivins, State Game Warden, Forsyth, Montana

SUBJECT: Wildlife Enforcement Impact of Coal & Energy Development in Rosebud and Treasure Counties

The specific facts and general statements contained in this memo refer to the time period of June, 1973, to the present. The reason I use June of '73 is that it seems to be about the first date of any significant impact on wildlife as a result of the energy development in Rosebud and Treasure counties. This time also coincides with the expansion of Peabody's Big Sky Mine south of Colstrip, the initial construction of Colstrip Units 1 & 2, Western Energy's expanded coal mining activities, and Westmorland Resources Coal Mine and related railroad spur up Sarpy Creek.

The biggest immediate impact of the energy-related problems has been a wholesale closing down to hunting on the ranches in this area. I couldn't stop to visit ranchers without hearing complaints that construction workers were continually traveling country roads and shooting at wildlife without regard to land ownership, roads, seasons, or limits. The most alarming truth to these complaints was that many of these animals and birds that were shot were not even taken or put to use. To cite an example of this activity, I have personally found portions of five deer in one day, in plastic garbage bags, at the Colstrip dump. In Sept. of '75, I observed at one time, portions of 3 deer, 2 antelope, 1 elk, 1 beef, and numerous grouse and trout---all discarded at the Colstrip dump. I have detected and charged some violators in relation to game animals thrown away at this dump. The number of animals appearing at the Colstrip dump is a far greater % than at the dumps of cities in the surrounding areas.

The Colstrip Trout Pond is a strip pit about 60' wide and 7/8 of a mile long. The Fish and Game has stocked it with catchable-size Rainbow Trout. This small area, which is the only one (public)pond anywhere within 25 miles of Colstrip, has accounted for more Fish and Game criminal apprehensions than all other fishing areas put together in Rosebud and Treasure counties. This, however, will no longer be a problem because Western Energy Co. is in the process of filling it in so coal can be mined adjacent to the trout pond.

HELENA, MONTANA

Office Memorandum

DATE:

TO :

FROM :

SUBJECT:

Another criminal violation type problem in the Colstrip area is Fish and Game Residency violations. The problem exists in locating transient types after the violation has been committed. This violation has been of such a magnitude that I haven't had sufficient time to pursue it justly and accomplish the other facets of my Game Warden job. The Residency violations that have occurred in the impact area could have taken the full time of one Game Warden to investigate and charge such violations.

I thought for awhile that my impact problems in the Colstrip area had subsided until a routine patrol in the Colstrip vicinity opening day of hunting season, 1975. Another Warden and myself detected and issued 8 citations on serious hunting law violations in a period of approximately five hours.

I don't mean to falsely accuse the transient workers, because a substantial number of the company men and high level officials in the energy industries have been involved in serious Fish and Game violations.

I have not even begun to scratch the surface in ragards to the wildlife-related problems in the Colstrip area. I am not, however, from a selfish job-related standpoint looking forward to the construction of Colstrip Units 3 & 4.

STATE OF MONTANA
DEPARTMENT OF FISH AND GAME
HELENA, MONTANA

Office Memorandum

TO : **DATE:** 1-26-76

FROM : James B. Heck, State Game Warden, Hysham, MT.

SUBJECT: Impact of Colstrip Development on Fish and Game Enforcement Activities

I have been the game warden in the Hysham district since July, 1974. This district encompasses, in part, all of Treasure County and that part of Rosebud County which lies south of the INterstate and west of Highway 315. This area does not include Colstrip itself, but the effects of the development are felt throughout this area.

I have spent some time evaluating the violations which I have encountered in Treasure and Rosebud Counties. Of the citations I have issued, 41 percent have been to residents of Colstrip or people living elsewhere, who I knew were employed at Colstrip. This figure would probably be somewhat higher if I knew where all of these violators were employed. I have had numerous complaints from landowners in this area regarding shooting from the roads, trespass, hunting without permission and spot-lighting of game animals out of season. It is difficult to determine what percentage of these violations are being committed by Colstrip employees, but it has been my observation that a large percentage of the traffic through these areas stems from Colstrip.

The introduction of a large number of non-resident employees into this area has created problems of residency violations in the purchase of hunting and fishing licenses. Out of state employees are moving to Colstrip and purchasing resident licenses illegally. It is very difficult to detect these violations for several reasons. Frequently these people are only employed for short periods of time and have departed by the time the violation is discovered. The housing situation in Colstrip makes it difficult and time consuming to locate individuals for questioning. In addition, the majority of the employees at Colstrip are transient workers, living in mobile homes and moving frequently from job to job. This makes checking on previous residences quite slow and uncertain. I would, however, like to commend the employers, trailer park managers, and security people for being very cooperative in aiding us in locating persons and supplying what information they can.

Probably the greatest single impact of Colstrip is on the attitudes of landowners in the area. The influx of such a large number of people into a rural area has created numerous conflicts and bad feelings among the ranchers in the area. Residents of Colstrip have moved into the surrounding country-side for recreational activities. These activities include hunting, fishing, motorcycling, and snowmobiling. Particularly in hunting season. The pressure on surrounding landowners is quite intense. It has resulted in the closure of much of the private land in the area to hunting and fishing.

The impact from Colstrip is probably no greater than any other "Boom Town" situation where large numbers of transient workers are brought into an area accustomed to rural activities, low population, and second and third generation residents.

This development has, however, created a substantial increase in problems with the enforcement of Fish and Game laws as well as our efforts to maintain good landowner sportsman relations in this area.

JH:fr